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"*La guerre est un métier pour les ignorans,*
et une Science pour les habiles gens."

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DETERMINATION OF LONGITUDINAL DEVIATIONS AT SEACOAST ARTILLERY PRACTICE BY THE AID OF PHOTOGRAPHY.

By CAPTAIN ADRIAN S. FLEMING, ARTILLERY CORPS.

The data required by the various blank forms for coast artillery practice may be classified under four heads, viz:

1st. That pertaining to the ammunition.
2nd. That pertaining to the gun and carriage.
3rd. That concerning the target.
4th. That concerning the fall of the shots.

The data comprised by 1 and 2 are always easily obtained. The range and speed of the target at any time can be determined quite accurately from the observations of the D.P.F. The data concerning the fall of the shots consist of the lateral and the longitudinal deviations. The former are usually small and a transit or similar instrument can generally be relied upon for their accurate determination, especially if at least two such instruments be used—one as a check on the other. It is the determination of the latter, i. e., the distance that a shot falls "short" or "beyond", that involves the greatest practical difficulty and these data are in almost every case extremely unreliable. It is a practical impossibility to waterline a shot splash accurately with a D.P.F., and I have several times seen excellent observers obtain a range for a splash that gives a "short" when the evidence of the range officer aboard the towing tug reported the shot "beyond" and vice versa. And to this evidence of the unreliability of a D.P.F. for such observations was added the indisputable proof of photography used as outlined below. A "T" in the hands of a well trained observer aboard the towing tug gives fairly satisfactory results, but under the best conditions the results obtained by its use are only rough approximations and when the sea is not calm no observer, however skilled, can do good or reliable work with it. For example, on two out of the first four occasions when practice at a moving target was held at Fort Rosecrans, the range officer reported that the towing tug was pitching and rolling so much that little dependence could be placed on the results of his observations. Observations from the ends of a horizontal base are more accurate than either of the above, but fog, etc., may obscure the splash at one or both of the stations (even when it is sufficiently clear to see the target from the batteries); one of the observers is apt to lose the splash, thus rendering the results of the other useless ; and even when they both obtain results the latter are likely to contain more or less error.

The result of the use of any of the three foregoing methods is the strong probability of unknown errors being introduced into our records of artillery firing, which affect the score, mislead the ordnance department (which is largely dependent on our records in order to give us good powder charges), and render the records useless as a guide for future firing. On the other hand some method that can be implicitly relied upon is extremely desirable, not only because it would absolutely determine the number of hits, but because it would furnish information concerning the gun, powder, etc., which is most valuable to the artillery and the ordnance department—a matter of far more importance. It is a well known fact that no two guns shoot alike, nor would the same gun shoot similarly if mounted on different carriages. This is equivalent to saying that every gun has what may be termed an individual error and the determination of such errors is of vital importance to insure good shooting. Such determination can be accomplished only by studying the record of firing of each gun in comparison with that of other guns, and can be of value only when these records are correct. All of which goes to show the necessity of an accurate means of determining how far "short" or "beyond" our shots fall, not for use during firing, since in action this would be impracticable, but in order to secure a true record for the purposes outlined above.

It occurred to the writer some eight months ago that photography might be advantageously employed for this purpose and he accordingly made the first experiment at the quarterly practice held in the artillery district of San Diego during March, 1903. The results were so encouraging that a report was made on this subject to the Chief of Artillery, which resulted in an allotment by the signal corps of sufficient funds to purchase a cartridge kodak No. 5 (5 x 7 inches) fitted with both rectilinear and wide angle lenses, also several films and a limited quantity of supplies for developing and printing photographs. The wide angle lens was desired for experimental purposes, since it was thought that it would give a much greater field of view and yet give sufficiently clear definition for all practical purposes. This proved to be the fact.

In the harbor of San Diego a 700 foot tow line is used when firing at all except long ranges and Case II. is used exclusively at artillery practice.

The camera is used aboard the towing tug to photograph the target at the instant the shot strikes the water. Experiment showed that at this distance the field of view of the camera (5 x 7 inches) using the wide angle lens averages 284 yards, while that using the rectilinear lens is only 194 yards. In other words the field of the latter is only 68½% that of the former lens, and a shot having a longitudinal deviation of more than 97 yards would not appear in a picture taken with the rectilinear lens while one having a longitudinal deviation of 142 yards would appear in a picture taken with the wide angle lens. From the accompanying photographs, which were all taken with this lens, it will be evident that the definition is all that is necessary. The great advantage of the wide angle lens where it can be used is thus made manifest. The next step was to construct a scale by means of which the deviations could be measured. Rows of equidistant stakes were set out as shown in figure 1, and photographed from the point **C** on a perpendicular to the center of the line of stakes, the camera being turned at various angles, and first the rectilinear and then the wide angle lens being used.

In all cases the two scales showing in a photograph were identical in size, the further line of stakes appearing, of course, above the nearer one. In those photographs taken with the optical axis of the camera making an angle with the perpendicular from the camera to the lines of stakes, the scales decrease towards the side towards which the camera was pointed, the mean being at the center of the photograph. It follows that unless the target always occupies the center of the field of view (a practical impossibility) a separate scale is essential for measuring the deflection of each shot photographed. Since the target may appear at any distance from the center of the field of view, within the limits of the breadth of the photograph, the following plan was devised: see Plate I.

A rectangle, the size of the photograph, was drawn and one diagonal constructed, the rectangle then being divided, for convenience, into $\frac{1}{10}$ inch cross sections. The median vertical line represents the center of the field of view. The intersection of the diagonal with the horizontal lines represents positions of the target on the water line varying in distance $\frac{1}{10}$ inch from the center of the photograph. On one of the photographs of the stakes, the distance to the center of the photograph from the point where the perpendicular $\mathbf{Cs}_1$ (see figure 1) intersected their line i. e., the position of the target, was carefully measured. At this distance from the median line in the drawing a parallel to the latter line was drawn and the intersection of this parallel with the diagonal located the target, i. e., the zero of the photograph used. A horizontal line was drawn through this point, the scale transferred from the photograph to this line and marked 25, 50, 75, etc., on each side of the zero. The other scales were similarly used. In

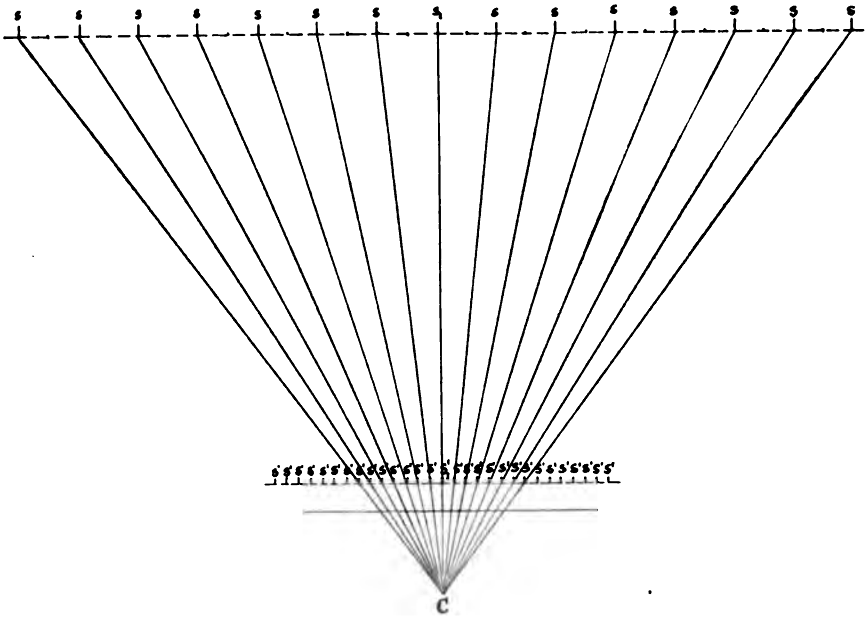


Figure 1.

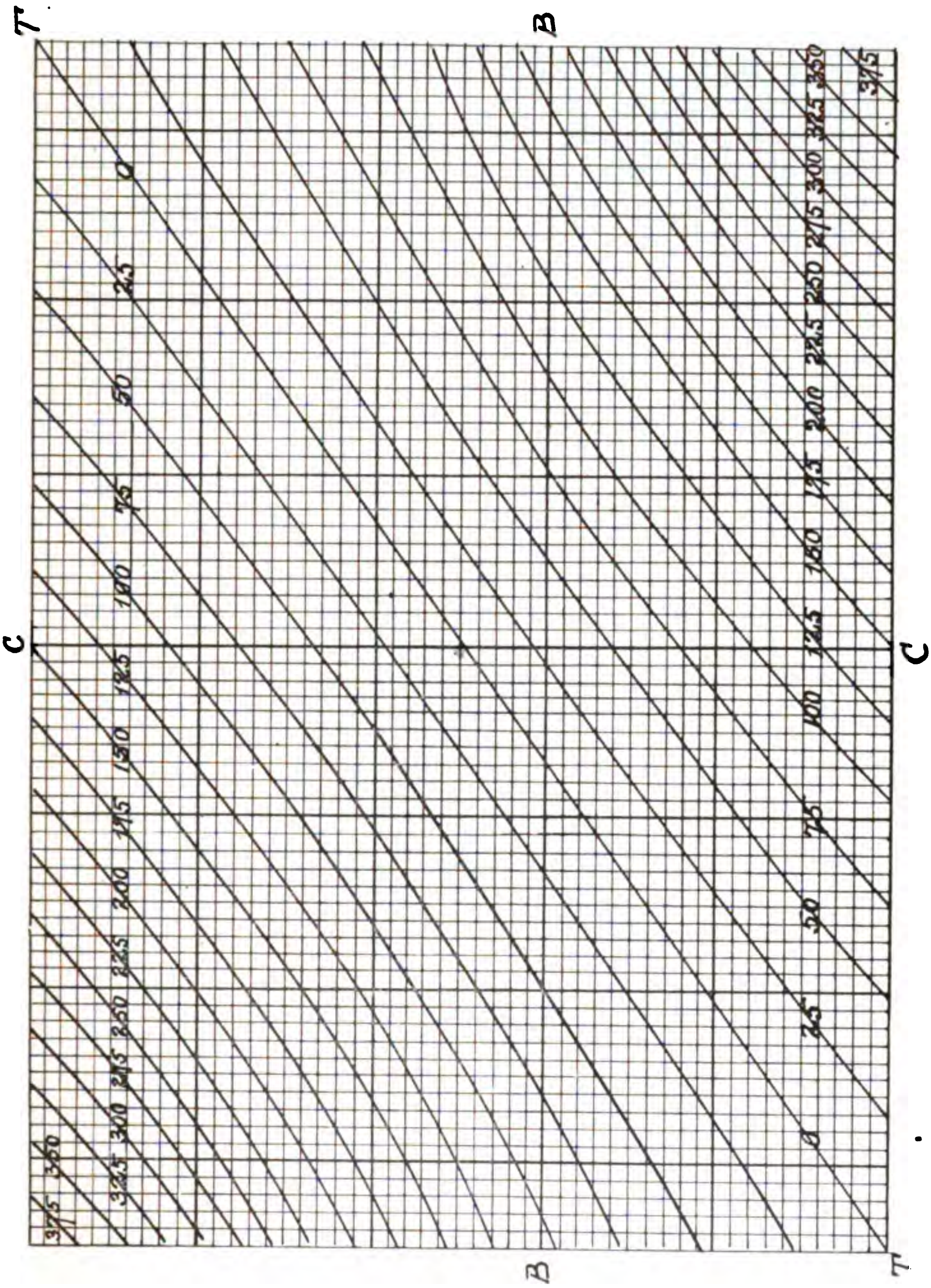
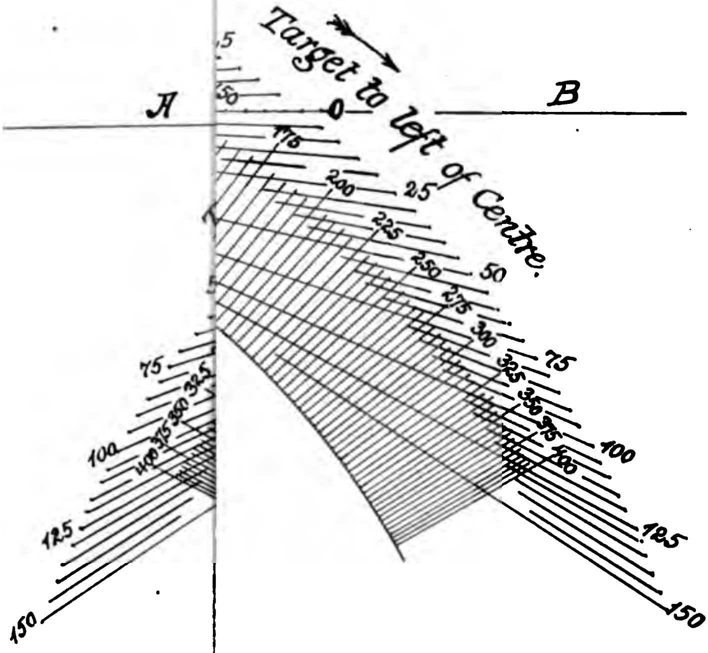


Plate I.

all six parallel scales were constructed on the drawing, all having their zeros on the diagonal. A curve was then drawn through the six points on the left of the diagonal marked 25, another through the six points marked 50, etc.; the curves on the right were similarly drawn. Each horizontal line is therefore a scale for a photograph in which the distance of the target from the center of the photograph is equal to the distance of the zero of the scale from the median line. In the drawing these latter distances vary by $\frac{1}{10}$ inch but for extreme accuracy interpolations may be made. An examination of these scales will show the necessity for their use when the target does not appear in the center of the photograph; when it does appear there, its scale is equidistant, as it should be, provided the lens is rectilinear. These facts are all the result of practical experiment, which I have proved graphically and mathematically. To use the scale for any given photograph of a splash, measure the distance from target to center of photograph. Find the parallel nearest this distance on corresponding side of median line and run down this parallel to its intersection with the "zero curve". The corresponding scale will be the horizontal line passing through this intersection. Next measure the distance of target from splash (in photograph), apply it to scale, and the result is the longitudinal deviation. The latter will be + (beyond) or — (short) depending on whether the splash appears to the right or left of the target (in the photograph) if the azimuth of the target was increasing and vice versa.

The scale thus described was found to be unsatisfactory in practice, since it is difficult to draw the curves with the requisite accuracy and it is an awkward scale to use. Further study evolved the scale shown in Plate II. The principles of the construction of this scale are as follows:

Assume that we have a photograph of a line of stakes 25 yards apart taken at a distance of 700 feet on a perpendicular to the line of stakes through the center stake, the latter appearing exactly in the center of the photograph. The distances between stakes in the photograph will be equal. (If the center stake does not appear exactly in the center of the photograph the distance between the extreme stakes appearing in the photograph divided by the number of intervals between stakes will give the above distance sufficiently close for all practical purposes). Draw an indefinite right line **AB** and lay out this distance on it 32 times, and subdivide each division five times. Through the central point so determined construct a perpendicular **PC′** and


Target to left of Centre.
A
B

lay off on it from **AB** a distance equal to the length of the tow line to scale. For example suppose the distance between stakes in the photograph is .625″, which represents 25 yards, and the length of tow line is 720 feet, the required distance is 6.0″. Through the point so determined **C′** and each of the points on the former right line draw an indefinite right line as **C′p**, **C′q**, etc., and also an indefinite arc (radius of 6.0″) tangent to **AB**. Lay off on **AB** on either side of **P** a distance equal to one-half the width of a photograph taken by the camera and through the point so determined draw an indefinite arc with **C′** as a center. At each point where the inner arc is intersected by the lines **C′p**, **C′q**, etc., construct a tangent limited by the outer arc. Each of these tangents will be the scale for use on a photograph in which the target is to one side of the center a distance equal to the distance from the point of tangency to the line **PC′** measured on the tangent.

The scale is constructed on transparent paper and marked in figures as shown in the drawing.

To measure the longitudinal deviation of a photographed splash by means of the scale proceed as follows:

Lay the photograph on a table and so place the scale above it that the line **AB** coincides with the water line, the point **P** being at its center. Note the reading on **AB** of the edge of the target which was towards the gun. Shift the scale until the same point of the target appears on the line **PC′**, the water line coinciding with the proper scale which is indicated by the outer figures which have the same reading as the above reading on **AB**, the scale being shifted clockwise if the target be to the left of the center of the photograph and vice versa; then take the reading, on the scale so determined, of the edge of the splash towards the gun.

If the line of fire be at right angles to the line from the tug to the target and there be no lateral deviation, the result will be true to the limit of accuracy of the scale, about .2 yards. But if these conditions do not exist the foregoing result in the apparent, not the real, longitudinal deviation.

The following figure will illustrate how a formula for reducing this apparent distance to the real one was deduced:

T is the position of target, **G** of gun, **S** of splash, and **L** of tug, i. e., of camera.

Denote the range of target **TG** by $\mathbf{R}_t$, that of splash **SG** by $\mathbf{R}_s$, distance of camera from target by **D**, lateral deviation in yards **Tb** by **d**, in arc by δ; the angle between **TG** and **TL** measured clockwise from **TL** by β. $\alpha = \tan^{-1}\frac{\mathbf{Ta}}{\mathbf{TL}}$ and is found by taking the angle whose tangent is the apparent longitudinal deviation divided by **D**.

The following formula holds true for all possible values of the quantities:

$$R_s = \frac{R_t}{\cos\delta} \mp \left(D\frac{\sin\alpha}{\sin(\beta+\delta\mp\alpha)} + \frac{d}{\sin(\beta+\delta)} \cdot \left\{ \frac{\sin\alpha\cos\delta}{\sin(\beta+\delta\mp\alpha)} \pm \cos\beta \right\} \right).$$

d and δ are positive when on the opposite side of target from camera. Where double sign apppears take upper sign when splash is on side of target towards gun and vice versa.

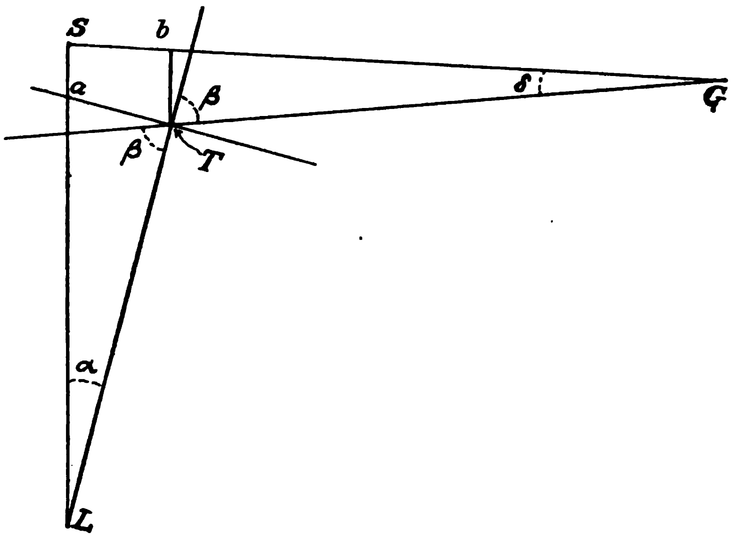
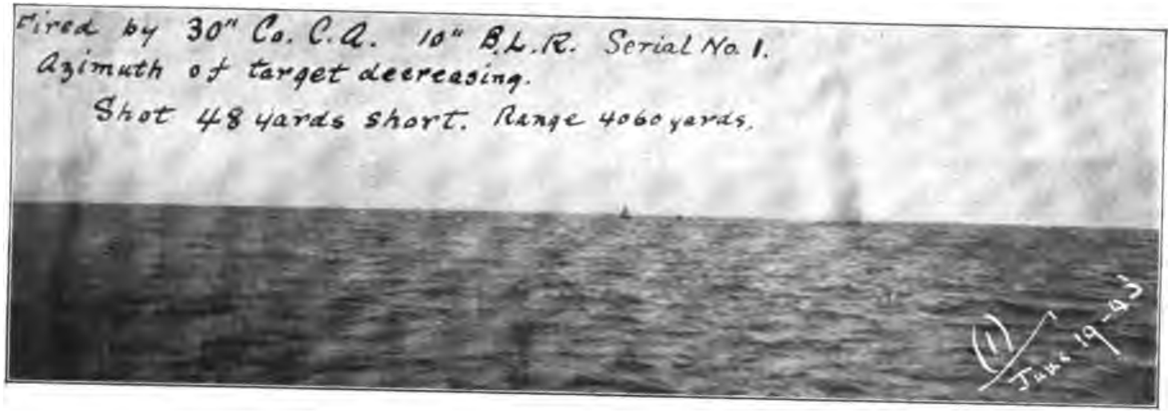


Figure 2.

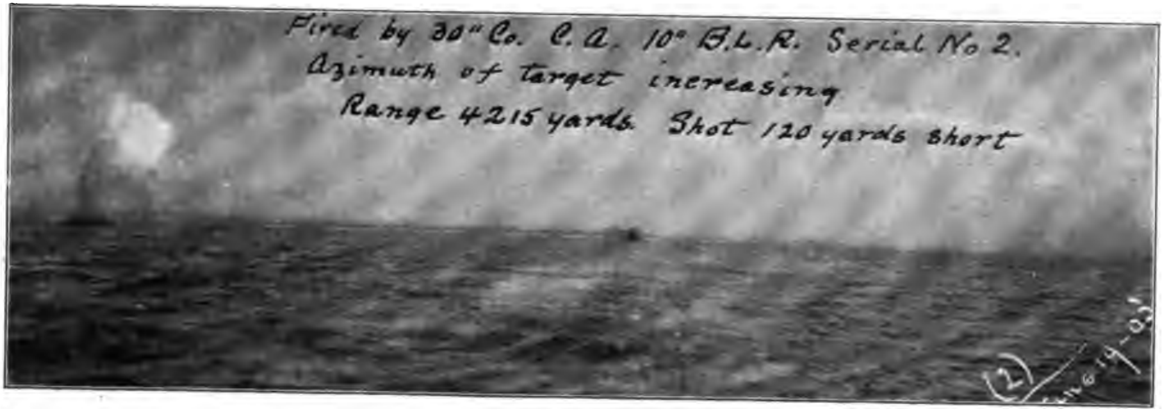
This formula gives the true range of the splash; then knowing the range of the target the longitudinal deviation is readily obtained. This formula is not so formidable as it looks, since for all line shots all terms except the first two drop out, **d** and δ being in such case equal to 0. Also unless β varies very materially from 90° or **d** is quite large, it will usually be unnecessary to reduce by it. For example the values for one shot fired by the 115th Company, Coast Artillery, were as follows:

$D = 233.33$, $\beta = 103.45$, $\alpha = \tan^{-1}\frac{21.4}{233.33} = 5^\circ\ 14'\ 25''$, $d = 0$,



Fired by 30" Co. C.A. 10" B.L.R. Serial No. 1.
Azimuth of target decreasing.
Shot 48 yards short. Range 4060 yards.

(1) June 19-03



Fired by 30" Co. C.A. 10" B.L.R. Serial No 2.
Azimuth of target increasing
Range 4215 yards. Shot 120 yards short

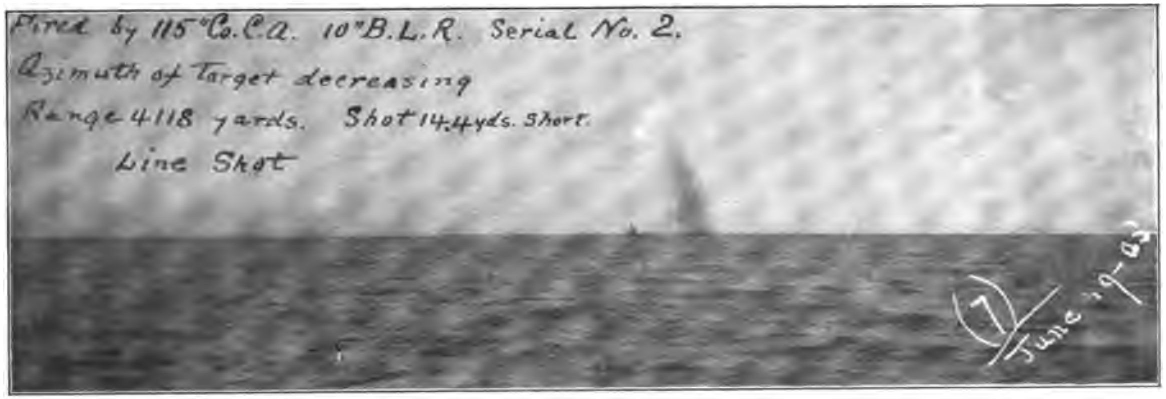
(2) June 19-03

Fired by 30th Co. C.A. 10" B. L. R. Serial No 5.
Azimuth of target increasing
Range 4473 yards. Shot 68 yds. short.

(5)
June 19-03

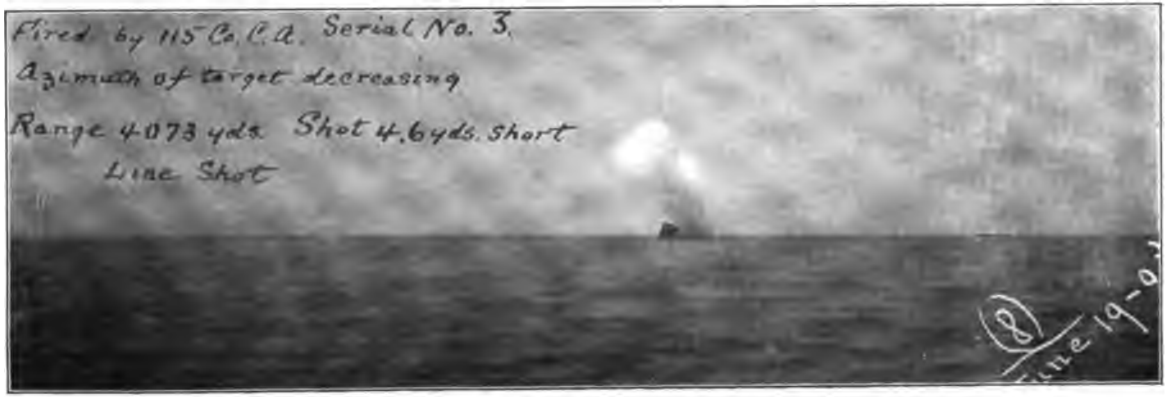
Fired by 115th Co. C.A. 10" B.L. R. Serial No. I.
Azimuth of target decreasing.
Range 4188 yds. Shot 225 yds. over
Line Shot

(6)
June 19-03



Fired by 115th Co. C.A. 10" B.L.R. Serial No. 2.
Azimuth of Target decreasing
Range 4118 yards. Shot 14.4 yds. short.
Line Shot

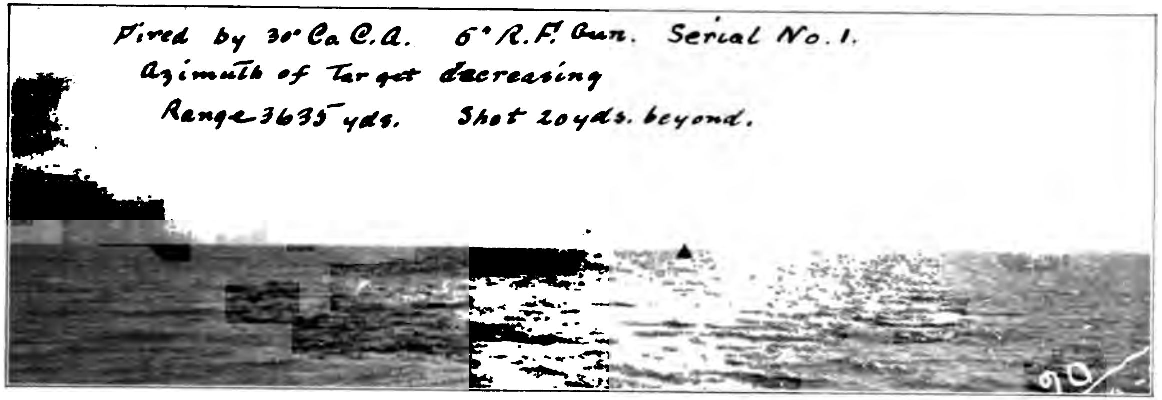
(7)
June 19-03



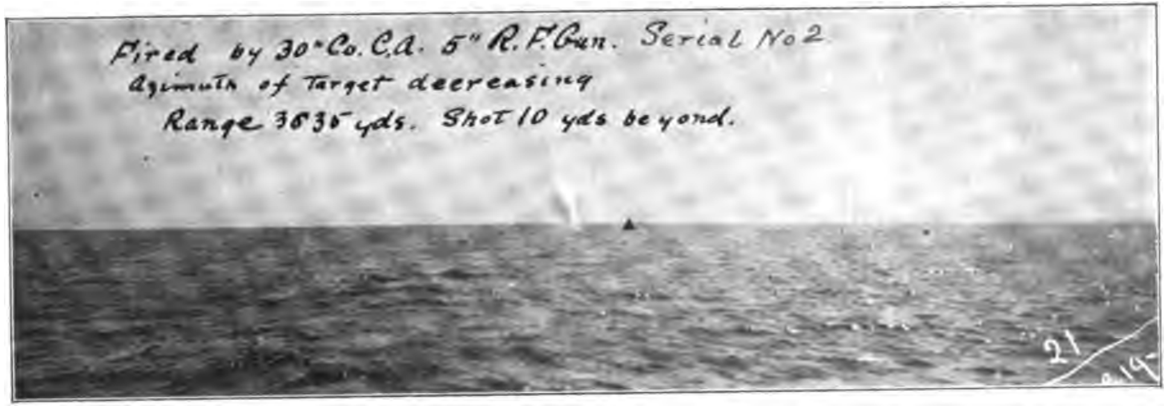
Fired by 115 Co. C.A. Serial No. 3.
Azimuth of target decreasing
Range 4073 yds. Shot 4.6 yds. short
Line Shot

(8)
June 19-0

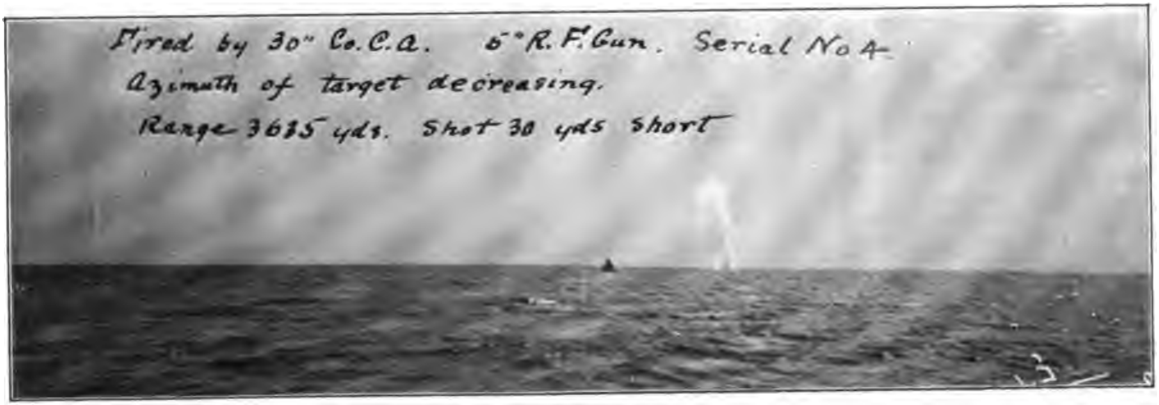
Fired by 115 Co. C.A. Serial No 4.
Azimuth of target decreasing.
Range 4035 yds. Shot 3.5 yds. Short.
Line Shot. Target Destroyed



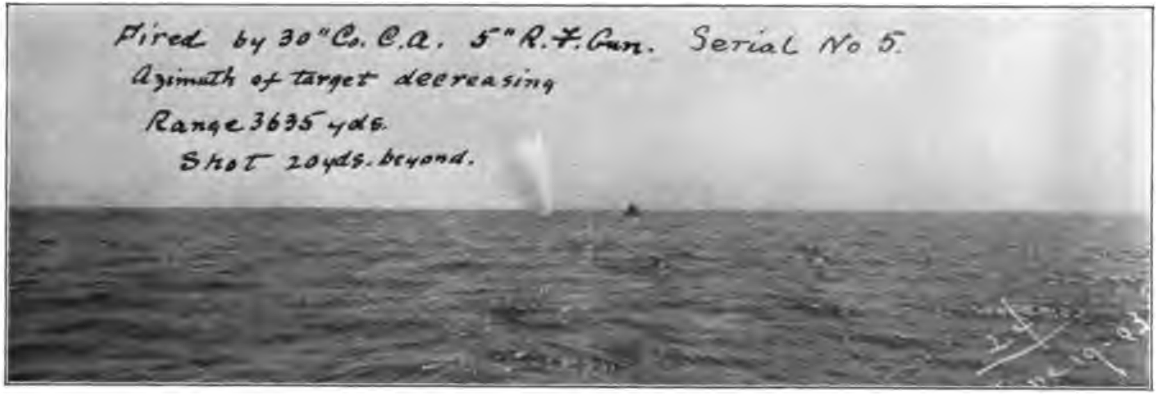
Fired by 30th Co. C.A. 6" R.F. Gun. Serial No. 1.
Azimuth of Target decreasing
Range 3635 yds. Shot 20 yds. beyond.

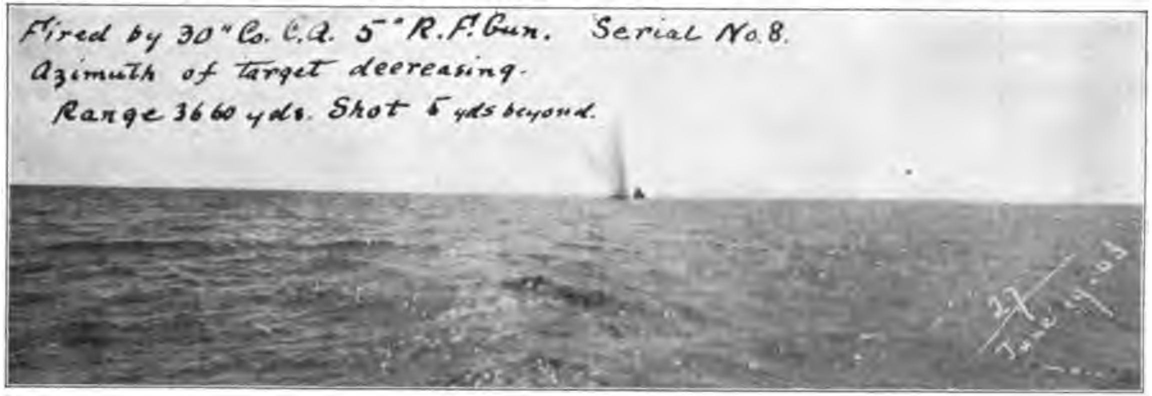


Fired by 30" Co. C.A. 5" R.F. Gun. Serial No 2
Azimuth of Target decreasing
Range 3630 yds. Shot 10 yds beyond.



Fired by 30" Co. C.A. 5" R.F. Gun. Serial No 4
Azimuth of target decreasing.
Range 3685 yds. Shot 30 yds short


Fired by 30" Co. C.A. 5" R.F. Gun. Serial No 5.
Azimuth of target decreasing
Range 3635 yds.
Shot 20yds. beyond.
24
19-03


Fired by 30" Co. C.A. 5" R.F. Gun. Serial No. 8.
Azimuth of target decreasing.
Range 3660 yds. Shot 5 yds beyond.
27
June 19-03

$R_t = 4188$. The reduced value of R_s was 4210.5, which gives 22.5 instead of 21.4 for the longitudinal deviation, the splash being over in this particular case.

On the other hand the necessity for its use is shown by the following example: Assume that the target is moving with decreasing azimuth and making an angle of 45° with the line of fire measured as above, that the deviation is 15′ right (corresponding to 17.5 yards at the range), the range of the target being 4,000 yards, the apparent longitudinal deviation as measured by the scale being — 40 yards, and the camera being 300 yards from the target. Applying the formula we obtain $R_s = 3912.8$, and — 87.2 for the longitudinal deviation.

This method of obtaining longitudinal deviations has been used by me on three separate occasions of artillery practice in the artillery district of San Diego. For ranges up to about 5,000 yards the wide angle lens and the scale shown herein are used, the length of the tow line being 700 feet, which experience has shown to be amply long for safety. For greater ranges a 1200 foot tow line and the narrow (rectilinear) lens were used, a separate scale being of course necessary in this case.

Using the wide angle lens, **D** being = 233.33, the width of the target in the photographs is .08″. If **D** were 400, the width of the target would be 0.027″ according to the laws of optics. It therefore seems practicable to use the wide angle lens at all required ranges and thus obtain the advantage of a wider field of view, viz., 241 yards on each side of the target, using a 1200 foot tow line.

In suggesting this method of determining longitudinal deviations I do not wish it to be understood that I favor the abolition of the methods at present in use, since the day might prove too inauspicious (though when there is sufficient light to see the target from the guns there will nearly always be enough to take a sufficiently good photograph); the camera might fail to work properly or to include the splash in the field of view when large errors in range are made. But when any result at all is obtained (and my experience has been that a competent operator can obtain a result nine times out of ten, and probably much oftener after becoming entirely familiar with his duties) it is unquestionable authority for that shot, and the comparison of such results with those obtained by the other methods would serve as an excellent check on such shots as they did not include.

The accompanying illustrations from some of the photographs taken at Fort Rosecrans, Cal., during the quarterly practice held on June 19, 1903, show clearly the results secured. The first ten shots were fired from 10-inch B. L. rifles. The ninth shot destroyed the target and the photographer, thinking that the tenth shot would not be fired at the debris, was unprepared and made no attempt to photograph the tenth splash. Seventeen shots were fired from rapid-fire guns. These shots were fired so rapidly that the photographer, as he afterwards explained, failed to set the shutter for the first three shots. Every shot of the remaining fourteen was photographed.

Considering that this was the second occasion on which such work had been done, and that it was the first time an attempt to photograph the splashes of shots from rapid-fire guns was ever made, the results are excellent.

THE SEMI-AUTOMATIC SIGHT.

By Captain ELMER W. HUBBARD, Artillery Corps.

This sight was submitted to the Board of Ordnance and Fortification in August, 1902, and an experimental form for the 8-inch barbette gun was built. On May 19, 1903, a joint patent was granted to Captains E. W. Hubbard and S. C. Vestal, Artillery Corps, and in August, 1903, the sight was tested and reported upon by the Artillery Board, at Fort Monroe.

PRINCIPLES.

1. To make the gun independent and self-contained in everything except range, and thus allow it to be used effectively in action up to the last possible moment.

2. To separate the principal deviating causes, such as wind, drift, travel of the target in the time of flight and error of last shot; to set the corresponding deflections independently and cause the peep or directing point to move automatically a distance equal to the algebraic sum of these separate settings.

3. To make the sight an observing instrument for travel of the target, in which the operation of taking the travel also adds it in automatically to give the total deflection. Similarly for lateral deviation of shot.

4. To have the elevation scale, wheel, or other device for giving elevations, graduated in yards, and equipped with a series of detachable scales for different muzzle velocities. Each scale to have also an adjustment whereby range corrections may be made independently of the actual quadrant elevation of the piece. This to the end that the elevation may always be set to the range actually posted, thus increasing the rapidity and lessening liability to errors.

5. To have the mechanical arrangements as simple as possible, and generally to have the sight so plain that any intelligent man can learn its use in the shortest time and with only a slight knowledge of gunnery.

6. To enable a battery commander to correct errors of range of one or more of his guns without interfering with the regular method of getting and sending ranges.

7. To enable the gun to fire rapidly and accurately at moving targets.

8. To arrange all deflection scales in such a manner both for open and telescopic sights, that when the index is to the right of the center, (zero), a right deflection is indicated and vice versa.

9. To have the "heads," (triple deflection scales), of all open sights for the larger calibers interchangeable, and the same for telescopic forms. This by adopting a fixed distance between the front and rear sights.

DESCRIPTION OF PLATES.

The plates represent the experimental form of the sight using the following parts of the present 8-inch bar sight, viz:

Steel bar or vertical limb.

Bracket, cut away ⅛ inch on account of added elevation scale.

Front sight increased in height.

Plate I. represents the sight closed. In this position the upper screw may be used precisely as in an ordinary sight with single scale.

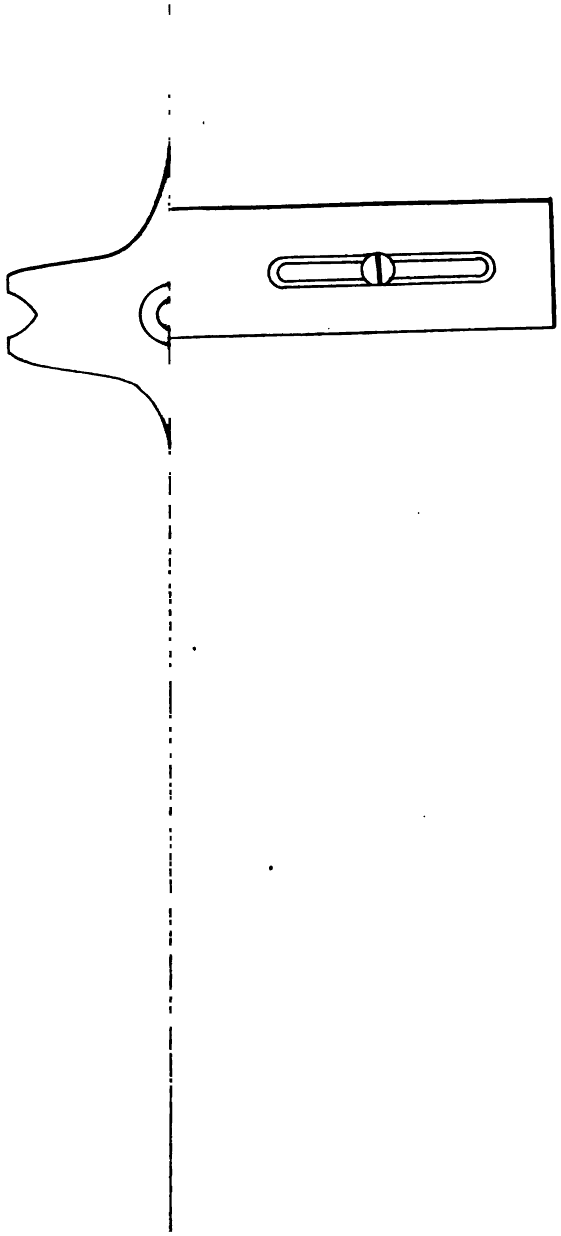
Plate II. is a view of the sight after the first shot and where splash has been caught with screw **b.** The deflections shown set are:

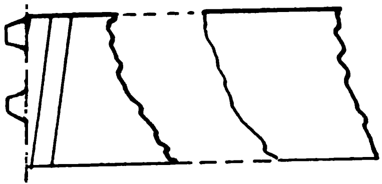
Wind	+ 40
Travel	— 35
Error last shot	+ 20
Total	+ 25

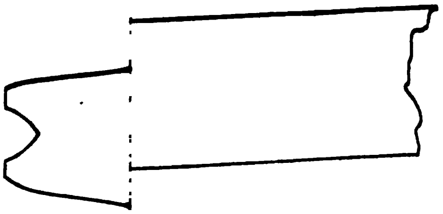
and the peep is at a setting of + 25 as shown by following down the vertical dotted line.

Plate III. shows the sight reversed for taking travel, except that the wind would ordinarily be set before reversing.

The experimental sight thus has the usual limb inclined for drift. To allow of graduating the limb in yards, and at the same time allow the use of differing powder velocities, or a powder which differs from the standard, detachable plates are provided, one of which is shown at **F.** Each plate is graduated for a certain velocity, which graduation may also include corrections for the height of the particular gun above sea-level, etc. The idea is to provide for each standard velocity, as 2200 f.s., several plates varying by 10 feet, as 2180, 2190, 2200, 2210, etc., to the end that the plate corresponding to the *actual* velocity may be used.







The plate **F** is also capable of a small motion up and down the limb by which powder or range corrections may be made as explained below.

H is a cap to provide a firm bearing and also to carry a vertical stud or pivot about which the "head" revolves.

Mounted on the limb is the "head." This consists of the base, **D**, and above **D** are three slides, **A**, **B** and **C**, dovetailed into one another without frame. The upper slide carries the peep and open sight. The base **D**, and hence the whole head, can be released by the lever shown and quickly revolved 180 degrees on the stud to the position shown in Plate III. for the purpose of taking travel.

The movement of any slide, as **C**, gives a corresponding movement to the peep, while at the same time the settings of the other slides are not disturbed. Each slide being thus independent, the separate deflections can be set independently, while the total movement of the peep is *the algebraic sum of the separate settings*, i.e., the total deflection. This addition is automatic.

The graduations on the slides and the wording have been carefully considered so as to be perfectly clear and so as to prevent as far as possible errors in direction. By means of the three slides a total deflection of 3 degrees can be given, which is more than will ever be needed in practice. The index, and not the scale, moves. The direction or sign of the deflection is thus evident.

The thumb-screws are opposite the corresponding scales. The screws have a very rapid pitch of 3/8 inch with sextuple thread for strength. On the reverse side is simply an index and zero for use in taking travel. See Plate III.

MANNER OF OPERATION.

Deflections.—Fixed target. Set the wind, leaving "deflection" screw **b** at zero. Catch splash by turning screw **b**. If the scale reads 20 right, the shot went 20 left, and hence the sight is set for the next shot. This 20 right sums up and automatically corrects for all lateral errors of setting, such as wind, drift or unknown. This mode of operation is similar to that in the usual single scale.

Moving target. Suppose that we have an ordinary single deflection scale. Place peep at zero, train on the ship and halt. Now move peep so as to keep the line of sight on for the time of flight of the projectile for the given range. Read the deflection, say 35 right. This represents the ship's angular travel, but it is evident that if "Fire" be now given, (travel alone considered), the projectile will strike behind the ship an angular distance equal to twice the ship's travel in the time of flight. Hence the scale must be read, the reading borne in mind, and the peep shifted over to the other side of the zero, or to 35 left. The gun is now traversed to bring the line of sight on the ship, when the gun will have the correct deflection to allow for travel.

In the semi-automatic sight this delay, mental effort and danger of wrong setting is obviated. The deflection for wind, (or wind and drift), and error of last shot are first set on the appropriate slides. During the loading, and as late as possible, the travel is taken. Set **D** at zero and turn entire head 180 degrees to the position shown in Plate III. Line of sight is now brought on by traversing the gun until it is just ahead of the ship. Halt the gun, and when ship comes on follow up for the time of flight by turning **d** which has now come into a convenient position on the right. As soon as time has elapsed stop **d**, turn head to the first position, bring line of sight on by traversing and fire at once, or at the end of the predicted interval, as may be the rule. By this process the travel is taken and also automatically added into the deflection previously set, thus giving the total deflection. Whether the travel is taken every shot would of course depend on circumstances. Travel once taken can be left as long as desired and the other deflections changed every shot if necessary.

As in the case of the fixed target, catching the splash by screw **b** sums up and automatically corrects for all lateral errors. The wind, or wind and drift, can be gradually changed as the angle between the wind and plane of fire changes.

Two points are to be noted in the above: 1st, that no consulting of the scale for travel was needed, nor was any calculation or mental effort required to get the total deflection. The travel scale was placed on for reference merely or to note whether the ship is changing her speed. Were the scale omitted the result in practice would be the same; 2nd, that it is a practical way of predicting for travel laterally. The speed or angle of approach of the ship is immaterial, nor does the gunner have to consider whether the travel is right or left, or what deflection he must give to correct for it. *He has only to perform a simple mechanical operation.*

From the above it is now clear why a separation of the deflection elements was made in the construction of the sight. Any constant deflection element can be left as long as desired and is all the time automatically added, while the variable elements can be changed every shot if desired. This separation also enables the deviation of the shot laterally to be recorded and corrected for without introducing any change at all in the usual methods of getting the deflections. For instance, if, as often happens, the sight standard shifts, catching the splash with upper slide corrects for it after the first shot. At present such error in the standard would probably remain uncorrected for in rapid firing, and probably undetected. In the cases cited it is impossible to accomplish the result with the ordinary single deflection scale without at the same time interfering with and complicating the usual process of getting and setting deflections.

The above mode of taking the travel differs from the usual methods by plotting board in so shortening the interval that a heavy ship will not have time to change either speed or direction materially before the projectile strikes.

As is well known, the usual method of determining travel by the plotting board is incorrect for two reasons :

1. The predicted and set-forward points are so far ahead of the last observation that the ship has time to change both speed and direction before the gun is fired.

2. Any error in locating the predicted track of the ship is reproduced in the lateral travel. The travel being the angle subtended by the line joining the predicted and set-forward point, it is evident that the angle may be varied considerably by a small change in the direction of that line. This line is also so short that the instrumental error of the plotting board is bound to be considerable. Errors due to the position finding system are also reflected in the travel.

In the mode of getting travel by the semi-automatic sight the travel is measured at the very point of fire and by an instrument having a radius of six or eight feet. Its accuracy therefore cannot be questioned. The errors are bound to be reduced to a minimum since the operations are such that the hand soon becomes trained to do them almost without thought.

This method also reduces the congestion in the plotting room which most officers consider a serious evil. When the gunner's corrector (see below) is used in connection with the semi-automatic sight, the plotting room is depended upon for nothing but the range, while the deflections are all taken care of at the gun and in the simplest manner. Deflection errors are thus almost entirely eliminated, while at present errors in both range and deflection are probable.

The Gunner's Corrector.—This is a device for giving automatically the deflection due to the sum of the wind and drift, or the wind alone in Case I. where the sight is inclined for drift. Space does not admit of a description but these two elements are given by simple inspection. The other element, the travel, by the sight as explained. The gunner's corrector may be attached to the plotting ruler, but in the complete system outlined it would form an attachment to the gun itself. The gun in turning would then automatically present right before the gunner's eye the sum of the wind and drift, and this he would simply keep set on the 2nd slide so marked.

The same mechanism also gives at the eye of the man at the elevating wheel the range corrections for wind. These he applies as described under "Ranges."

This device is not a part of the semi-automatic sight, but greatly facilitates its use. In rapid fire guns it is essential to the sight, but in H.P. guns deflections may be obtained by any method, only that travel is not included.

Ranges.—Suppose we know accurately the muzzle velocity of the powder charge, then the corresponding plate or elevation wheel is put on. If the ranges are still off, it may be due to atmospheric influences or to unknown causes. Correction may now be made *for any particular range* by the adjustable movement of the plate itself, independent of the actual quadrant elevation. Simply bring the plate, by loosening the screws, so that it reads the observed range. In doing this the quadrant elevation is not disturbed. Elevations are now set as they come from the plotting room and fictitious ranges are avoided, the elevations being now set to the actual numbers. This correction, while strictly correct for the one range only, is approximately correct for other ranges.

A correction which is true for all ranges is made thus. Suppose the muzzle velocity is unknown. Put on a plate marked with the estimated velocity and fire a shot at, say, 5,000 yards elevation. The observed range of the shot is 4,500. Take off the plate (or wheel), leaving the gun at its present quadrant elevation as before, and by trial find a plate which, when in normal position, reads 4,500 yards. The scale is now obviously correct for all ranges and the powder velocity has been found with sufficient accuracy for practical artillery purposes. The normal position referred to is when the zero of the scale at the small window is opposite the arrow on the bar. Error of the day can now be allowed for as before by the arbitrary scale shown, or by trial shot, as previously explained. The mechanical arrangements shown for shifting and changing the scales would be improved in future construction.

If required for ballistic purposes the degrees can also be put on the side of the bar, or in any position where they are not seen.

A similar adjustment has been proposed by having the index move instead of the scale, index to move over an auxiliary yard scale marked + and — . This form has certain advantages over the one described, but the principle is of course the same in both.

The index would then be set to the actual range of the projectile. It would then show the amount of such shifting on the auxiliary scale attached to the carriage (or bracket). This would enable a definite number of yards to be added or subtracted. The scale would be graduated for mid-range. The index can also be equipped with an automatic adding device similar to the sight head by which several elements may be set and corrected for. This scale would be graduated for mid-range which would introduce a slight error. Under this plan the corrections would be kept set by a N.C.O. and the man at the elevating wheel will simply keep it set to the posted range.

USE OF SIGHT IN CASE II. DRILL REGULATIONS.

This form of sight is particularly adapted to Case II., as it is designed to be used in continuous aiming which cannot be well done by Case I. in guns having a recoil and where sight is attached to the breech. It will also be difficult to catch the splash, and the operation of loading will interfere with getting the deflections as described.

In Case II., however, no such difficulties arise. In this case wind and drift are given automatically and set on the 2nd slide which would be so marked. In using the sight in Case II., no new principles are involved, the head going on the standard and and the elevation scales being adapted to the wheel, with devices for quick shifting, or shifting index as outlined.

The sight as described and constructed is thus only an expermental one. The principal reason for making it a Case I. sight was that it then combined in one instrument both the range and deflection principles.

TELESCOPIC FORM.

The principles as given can be easily applied to the telescopic form of sight. The slide **A** will terminate in a pivot fitting into a slot on the under side of the telescope near the eye-piece. The horizontal wire will be omitted. The vertical wire will be fixed and the telescope fastened to a bar, which bar will be pivoted far enough forward to give the requisite length of deflection scale. The various operations will then be precisely as described, the deflections will be in the proper sense, as in the open form, and confusion as to right and left is avoided.

USE ON RAPID FIRE GUNS.

Here, with a rapidly moving target, the great problem is to get and set the total deflection quickly enough to be of any value: This the sight, in connection with the gunner's corrector, does. The gunner's corrector here forms part of the gun equipment and gives constantly before the gunner's eye the deflection due to wind and drift combined, for any azimuth of the gun or of wind. This is set on slide **C** and the operations are as described.

The gunner is thus relieved of the deflection problem and can give his whole attention to correcting his ranges. At present, with both range and deflection problems before him, each shot is largely guess work and subsequent shots may, and probably will be, little better.

GENERALLY.

The necessity of simplifying fire direction methods in coast artillery work is generally recognized. This requires that nearly all operations shall be performed mechanically, and if possible automatically. On the other hand, if the mechanism is too complicated or easily put out of order little is to be gained by its use.

A system which requires data to pass through a number of persons is likewise objectionable. Although a complicated system may work well in peace time with trained men, it must be remembered that in war time experienced officers and men will be scarce. Our fire direction system must then be such as to be easily comprehended and one that will work accurately and quickly with a minimum of training and of expert supervision.

The gun is the ultimate unit. In any serious action it is reasonably certain that a time will come when each gun must be fought independently and without regard to whether the range finding system or other guns are working or not. Nor will this necessarily be at such short ranges that all fire direction can safely be omitted.

At present we seem to have put all of our eggs into one basket, and have nothing to fall back upon in case of a disarrangement of the usual system. The breaking of a wire, the dropping of a sight, will put a gun out of action effectually as far as hitting is concerned. Therefore, whatever fire direction system is adopted as the best, it still remains true that each gun should be provided with devices which will enable it to do effective work when thrown back upon its own resources. This is what the semi-automatic sight does.

This necessity is recognized in the automatic sight. The complicated mechanism involved in this solution, however, appears to make it extremely doubtful whether it can be successfully adapted to H.P. guns. The automatic sight admittedly is not accurate as a range finder. It is not therefore a satisfactory solution of the range problem, and in its use we are no nearer than before to a solution of the deflection problem.

In fact the range itself has been given possibly an undue weight. It is the elementary basis of all firing, but not the only thing to be considered. In default of an accurate range finding system the ranges can be got by buoys, intersection of the plane of fire with the channel line, etc. The true principle in firing would appear to be first to secure line shots in the simplest manner. Then fire short and correct in range. With the deflections out of the way the whole attention can be concentrated on the ranges.

The importance of getting certainly line shots cannot be exaggerated. A line shot, even if out in range, is bound to be more demoralizing to the enemy than one which is perfect in range but which falls in front of or behind him, for he will reason that on the next shot we will correct our range and score a hit.

The semi-automatic sight is thus an attempt to embody the principles above in a device which is at once inexpensive, mechanically simple, easy to understand and use, and effective. It is designed so that under war conditions a larger proportion of hits may be confidently anticipated than with the more complicated methods which require long practice and a considerable knowledge of gunnery.

CONCEALMENT OF COAST BATTERIES. ITS VALUE AND THE RELATION OF DISAPPEARING GUNS THERETO.

By Captain T. BENTLEY MOTT, Artillery Corps.
Military Attaché, American Embassy, Paris, France.

The numerous papers and discussions on the value of disappearing guns recently published have barely touched upon one of the advantages of the disappearing system. This advantage I beg leave to bring out more fully, especially as I have had much experience of a nature to qualify me to examine this part of the subject.

I think it proper, however, to say in the beginning, since the disappearing gun is a matter of controversy, that I am not an impassioned advocate of either system as against the other, believing as I do that each has its advantages and perhaps its place in our scheme of defense.

The relative cost ; relative protection afforded and the moral value of this protection ; relative complexity and liability to break down ; relative accuracy and relative quickness of fire of the barbette and disappearing systems, have all been minutely weighed by the friends of each. These may be regarded as the opinions of the defense ; I wish to bring out here the opinion of the attack, the way the matter looks to the enemy who will have to locate these batteries and fire at them.

When a squadron approaches for the purpose of attacking a harbor's defenses or forcing a passage, its information as to what it has to contend with is obtained from three sources :

1st. What has been learned and set down in time of peace concerning the location and armament of the land works.

2nd. What is learned on the spot from reconnaissances by small craft.

3rd. What is seen in the course of the attack—whether a reconnaissance in force to draw fire, or actual attack to subdue or run the batteries.

Let us take these in order.

1st. It is presumed that the intelligence department has furnished each ship with a harbor chart having each battery and its armament located on it with approximate accuracy. If the works or guns or both are well defined, a good ship's telescope at 8,000 or 10,000 yards according to the light, will enable these positions to be verified and accurate bearings taken. That mere chart indications, however, would be sufficient to justify the ship in opening fire, I do not personally believe. If, however, the information given by the chart were verified by seeing the guns, then there would be both bearings and target to furnish range and azimuth data. If the guns are mounted in barbette, nothing can prevent their being seen in clear weather. The works themselves may shade off into the natural features of the landscape and puzzle the observer, but a 10-inch barbette gun cannot be concealed from a practised eye.

If the guns are disappearing, the information given by the chart is always more difficult and sometimes impossible to confirm. Some works must from their location be conspicuous, guns or no guns; but in general, coast works can be so treated as to make their location most doubtful at reconnaissance ranges. This doubt as to the exact location of the batteries they are to attack, is depressing to the captains and the gunners as they approach within range, and it prevents ranges being easily taken with instruments or by picking up.

All of our disappearing batteries have probably been built since the coast was newly mapped. If it be stringently prohibited to indicate the place of any work of defense on any county, state, coast or geological map, foreign intelligence offices would find great difficulty in locating most of our batteries on their charts with enough accuracy to be useful for range purposes. Precious indications of this kind are furnished by many European maps; for example the navy coast charts and the general staff maps of several European states show, located with instrumental accuracy, forts which it would otherwise be most difficult for any unauthorized person to set down.

We cannot prevent the number, caliber and approximate location of our guns from being known to foreign navies, but we can prevent our forts from being set down accurately on our charts.

2nd. What is said concerning the first source of information applies to the second. An officer commanding a torpedo boat might be given a copy of the naval intelligence chart to verify or ordered to make a rapid reconnaissance, if the location of the works were not known. If the works are armed with barbette guns his work would be very simple as compared with what it would be with correctly concealed disappearing batteries. In the first case his report would in all likelihood be fairly accurate ; in the second it would be mostly guess-work.

Thus, from the first and second points of view the disappearing mount perplexes the reconnoitering squadron far more than does the barbette.

3rd. In the case of serious attack, either as a reconnaissance in force or pushed home, the ranges preferred by naval men are close. This means that all guns which show above a parapet can be attacked with direct aiming ; the various land batteries can be apportioned among the attacking ships, and each gun-captain can keep his target constantly in view, see the results of his fire and note from what work he is in the greatest danger.

If the batteries attacked are armed with disappearing guns, it is impossible to keep the target always in view ; a vague bank of earth or clump of brush (supposing the slopes correctly treated), is all that is constantly in sight ; a disconcerting effort is made to wait and fire just as the gun rises to position ; this, combined with the movements of the ship, the changing rate, parallax and the short time of visibility of the target, all combine to make good practice most difficult. The effects of the fire cannot well be judged and a gun might even be put out of action without its being certainly observed.

With brown powder these considerations would not have the weight they have today when smokeless powder is a necessary adjunct to the concealment afforded by the disappearing mount.

Again, there is surely a very severe moral effect produced by a silent battery whose position and strength is only guessed, whose fire is being reserved and probably prepared with calm accuracy and upon which the effects of the attack cannot be seen. The barbette battery on the contrary, stands out as clearly as the ship and the force of mystery is wanting to it.

* * *

The above statements if to any extent true, lead to these conclusions :

That the disappearing carriage permits a concealment of a battery's position and produces an effect of uncertainty upon the attack which is wholly impossible in any form of barbette mount.

That the disappearing gun offers not only a smaller target showing only at intervals, but the position of this target is difficult to locate and keep in sight.

That from a naval point of view a disappearing battery is much more difficult to attack than is a barbette battery.

That in order to derive the most benefit from these serious advantages, the location of batteries of disappearing guns should to a certain extent be determined by the concealment afforded; that the parapet, slopes and ground adjacent to a battery should be so treated as to mingle as much as possible with the general features of the landscape as seen at from 2 to 5 miles, and a study of the appearance of each work at this distance should be made by the fort commander.

That rapid-fire batteries mounted in barbette, and especially those having shields, should not be mounted alongside disappearing guns but should be placed off to themselves, if it is possible so to arrange it.

A 4-inch rapid-fire barbette battery with shields is as conspicuous from the sea as a 10-inch barbette battery. The shields should be painted so as to conform to the colors about the battery; but effectual concealment being impossible, these guns should never be so placed as to be a tell-tale upon the great guns.

That steps should be taken to prevent effectually coast works from being located on any map prepared by either private or public enterprise.

If any officer should doubt the essential correctness of the above principles, I would suggest that the next time he comes to Europe he arrive, for example, by way of Cherbourg and depart from Havre. If he looks about him as all passengers do in entering and leaving a harbor, he will find that even from the unmolested deck of a peaceful ship aided by a good glass at a mile range, he cannot find certain mortar batteries which all military men know defend the roadstead of Cherbourg. On the contrary, he will see about him any number of guns, though in many instances the works in which they are mounted are wholly inconspicuous. The reason for this distinction is that the mortars are not in barbette and the guns are. If he wants really to see a mortar battery he has only to sail within 5 miles of the shore at Havre and there one stands clearly visible, because these mortars are mounted in barbette. The question which this officer might profitably ask himself is: Suppose I were in command of a squadron attacking this port, which would I prefer to find opposed to me, these barbette guns which I plainly see and can reckon with, or those pieces hidden over in that direction among the trees or behind that vague mass of earth, which, indeed, may be an innocent hill for all I know or can tell, even when shots seem to come from it?

One more question will inevitably follow in his mind:

If there exists a country whose adopted coast artillery is of such happy construction that most all of it can be rendered wholly inconspicuous, what extraordinary force or fatuity prevents this concealment from being undertaken at once?

If that country were France, a Frenchman might, following national habits, grow violent and cry "the country is being sold by traitors!" ; if England, the whole world would probably agree that it was the usual British stupidity ; but being America and there being no politics in it, the answer is beyond the ability of at least one earnest seeker.

FIELD ARTILLERY ARMAMENT.

By Lieutenant-Colonel A. D. SCHENCK, Artillery Corps.

Heavy Field Artillery.—Earl Roberts is reported as saying: "The most important of the many lessons learned in the South African War, to my mind, is the necessity for including heavy long-range guns as part of the equipment of every field army." Under the heading, "Do we need field artillery?" an article, by General Murray, K.C.B.,R.A., appeared in the August and September Proceedings R. A. Institution. Among other things he said: "The demands of peace are always for increased mobility; the demands of war are always for heavier shell power. We have not sufficient fast-moving (horse) artillery for our wants, more especially having regard to the fact that the importance of mobility is receiving increased attention, and that it is probable that in the future we shall have a much more largely increased use of mounted troops than in the past.

We have not a sufficient proportion of heavy artillery for our field troops; call this artillery heavy field artillery, position artillery, or what not. I mean guns possessing the maximum of shell power consistent with a sufficient modicum of pace and mobility to keep well up with dismounted troops. Is it necessary to maintain an intermediate class of artillery, which is too fast for the infantry, and too slow to keep pace with the cavalry?"—Notes of Military Interest for 1902. A. G. O., January 1903. No. 38.

The demands of peace are not alone for increased mobility, which is chiefly for the horse artillery, but it has also often been coupled with one for a gun that will serve two purposes. Every military service has tried this experiment, and every time it has been subjected to the test of war the failure has been certain and great. Whether measured by past experience, by dynamometer measurement, or by the amount of power a horse can exert under war conditions as measured by the power in the forage he can eat and burn, (as for coal in a steam engine), it has been found that the loads an artillery team can pull in war are about 3,300, 3,900 and 4,800 pounds for horse, light, and heavy field artillery respectively, and with these loads there can be carried in sufficient numbers to meet battle conditions, projectiles weighing say 9, 15, and 23 pounds, respectively.

Now from an inspection of these numbers, the difference seems so immaterial that apparently a compromise is really possible, and hence the endless attempts in peace times to secure a desired simplification, which the test of war has always demonstrated to be impracticable. The increase of the load for the light field gun over that for the horse artillery gun is only about 18%, and for the projectile 66⅔%, with very nearly the same difference between the light and the heavy field gun, and it seems impossible for not a few intelligent military people to understand why such small differences as seen in times of peace, make such vast differences in their tactical applications in war.

It is often asserted that the powers of shrapnel shell vary as the cubes of their weights. While this is not strictly true, it is sufficiently near the truth to illustrate what a wonderful difference there is between such shrapnel as represented by the weights above named, viz: 9, 15, and 23 pounds, or as 729 : 3375 : 12167. In other words, for the light field gun an increase of only 18% in the load and 66⅔% in the weight of the shrapnel over those for the horse artillery gun, has increased the power of the gun 463% ; and for the heavy, as compared with the light field gun, when the load and weight have been increased 18 and 53%, respectively, the power of the gun has been increased 360%. But this is not all by any means ; in each case we have a measure of *mobility* which the war experiences of many nations through generations, have demonstrated to be such as to meet fully the *tactical* requirements of war.

As the differences in the respective loads and projectile weights are actually and relatively small, they at once reveal the secret of the failures when changes have been made in order to secure a desired end. A very small change in what has been proved by experience satisfactory in some army, has upset the absolutely essential conditions that must exist to insure efficiency, and has destroyed the efficiency of the gun either through want of mobility one way, or want of power the other way, and sometimes even both ways, in trying also to carry an undue number of rounds of ammunition per gun.

So long as the horse remains the same, the requirements as to the load for a horse artillery gun to keep pace with the cavalry remain unchanged from generation to generation, even though the country may be different and the roads change ; cross country must be covered, under much the same conditions whatever the time or place. The power of such a gun must of course be the maximum possible, coupled with the condition that a large number of rounds per gun must be carried in service with cavalry when supply conditions are precarious, and material limited to a minimum, which spells a light projectile. For the infantry only a certain proportion of the guns necessary can be assigned to its divisions without a too great interference with its tactics. Hence we must have the maximum power again, but only sufficient mobility to keep pace with the division over all kinds of ground over which it can readily maneuver, and the horse artillery gun is both too light and wanting in power to serve this purpose; and so again in turn for the heavier gun, which completes the complement and seems to form the corps artillery and to meet the most important tactical requirements of all large bodies of troops in war. It follows the infantry divisions, has the advantages of the roads with less demand for cross country work, and permits of the maximum power of fire, with only sufficient mobility to move freely with large bodies of troops.

In every war of any importance since field artillery has become reasonably mobile and well organized for the purpose, the tactical requirements for these three classes of guns has been demonstrated beyond a doubt, and although the batteries themselves, drawn up side by side—their projectiles and material, are very much alike in every respect, with apparently astonishingly little difference, the actual difference in mobility and power of fire is in reality marvelously great. Not one of these guns can be made to serve the purposes of the others to any advantage under general conditions of war, as scores and scores of efforts to do so have conclusively proved in campaigns and battles without number ; leaving the only possible effective solution of the problem that of constructing each gun solely to meet the particular conditions incident to its restricted services, without any regard whatever for those which apply to the others in so far as respects mobility and the resultant power of fire. Each gun in its own sphere of action is of necessity the best of its kind, and the only one that can possibly be expected to render the maximum of efficiency under war conditions, and meet the expectations and approval of commanding generals. A horse artillery gun that cannot keep up with cavalry on long and rapid marches is worse than useless to a cavalry general, and he will have none of it no matter what its power of fire may be. If we have not a powerful and mobile heavy field gun, the general, like Earl Roberts and many another before him, will soon regret the defect, no matter how perfect and powerful may be the gun, or perfect the organization and equipment of the light field artillery. A combination of the three are as necessary as is a combination of the three arms of the service, for a proper solution of the tactical problems incident to battle.

THE ARMORED CAISSON FOR FIELD ARTILLERY.*

By Captain T. BENTLEY MOTT, Artillery Corps.
Military Attaché, American Embassy, Paris, France.

In various reports during the past three years I have described the system evolved by the French for the rapid service of ammunition to the R.F. field gun and for the almost complete protection of the seven men serving the piece. The manufacture of our new R.F. field guns is well under way, but I am informed (lately by Captain Joyes) that while the caisson is probably designed, its manufacture has not yet begun. It is therefore opportune to present in a definite way what seem to be the advantages and defects of the French system, in order that once more the matter may be brought before those competent to decide the question. Apart from the theoretical considerations which I have long pondered over, it has recently been my privilege to see within the course of a single week the work in the field of batteries of French guns using the principle and the resulting tactics of the armored caisson, and batteries of English guns (Ehrhardt and Woolwich models) using the principle and the resulting tactics of the unarmored caisson. The contrast was so instructive to me personally that I hope I may be pardoned if I am led to urge with some vigor the conclusions drawn.

A glance at the following illustrations will show the French arrangement in battery and only a brief description need be added. Figs. 1 and 2 are of the same piece and caisson; they were taken by me and represent accurately what is seen in front and what is seen in rear of a gun in action; Figs. 3 and 4 show further details of construction in what concerns the shields and caisson.

The gun shield is seen to be hinged below, so as to turn up for traveling over rough ground; in figs. 1 and 2 the lower part is up; in 3 and 4 it is down. A small shield specially protects the laying apparatus. The trail of the caisson is hinged and is broken down on unlimbering simply to avoid giving a high target and good aiming point to the enemy. The water bucket is seen on this trail, carried there for convenience. The bottom of the caisson chest, which is turned to the enemy in action, is of bullet-proof steel; the doors of the caisson chest are similarly of bullet-proof plate. The thickness of these shields is not known exactly. That of the gun shield looks to be a little more than ¼ inch; the bottom of the caisson is doubtless the same; the doors may be thinner, as all shots from the front must strike them obliquely. At any rate, these shields are all bullet-proof at short ranges.

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* Communicated by the Chief of Artillery, U. S. A., and published by courtesy of the Military Information Division, General Staff, U. S. A.

The limbers of all the guns are moved off in a group to the best cover obtainable within a few hundred yards. Two of the extra caissons unlimbered are posted on the flank; the other six caissons are in rear under cover.

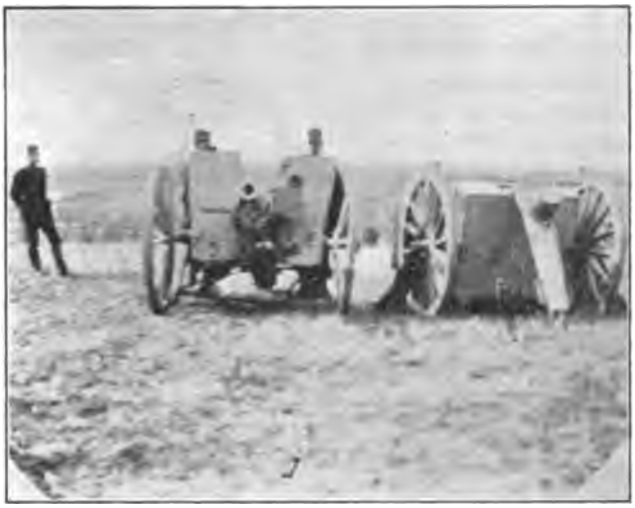


FIG. 1. French field gun in action. View from the front.

The disposition of a gun and limber in the unarmored system is too well known to need any reference, being the method we now employ with the 3.2-inch gun. It is useful to remark, however, that the English batteries of Ehrhardt or Woolwich guns, after posting the limbers about 20 yards in rear of the guns, unhitch the teams and move them off to cover as just explained for the French teams and limbers. This system with the English is undoubtedly the result of their South African experience, where the teams suffered so severely from musketry, and it is very important to bear this in mind in following the comparison about to be made between the two systems.

Let us now examine the tactical advantages of the French and English methods. I say English, because it seems that we must accept now or after a few fights the modification they have made in our arrangement, for the horses must be put under cover on most occasions or else the guns will often be rendered motionless.

1. Protection.—The seven men serving the gun and ammunition are almost entirely protected from musketry and shrapnel fire coming from the front. The fuze setter is wholly protected and can set his fuzes without excitement.

2. Ammunition supply.—The caisson being only 2 or 3 feet to the left of the gun, a supply of 72 cartridges is available without a man having to move from his post. The extra caissons on the flank contain 144 more cartridges available for the 4 guns. Thus each gun has 108 cartridges to shoot before caissons need be called from the rear. In most cases a gun will not be required to fire that many rounds in one position; on taking up another position the full caissons would be left with the guns and the empty ones moved to the rear and filled from the limber chests under cover.

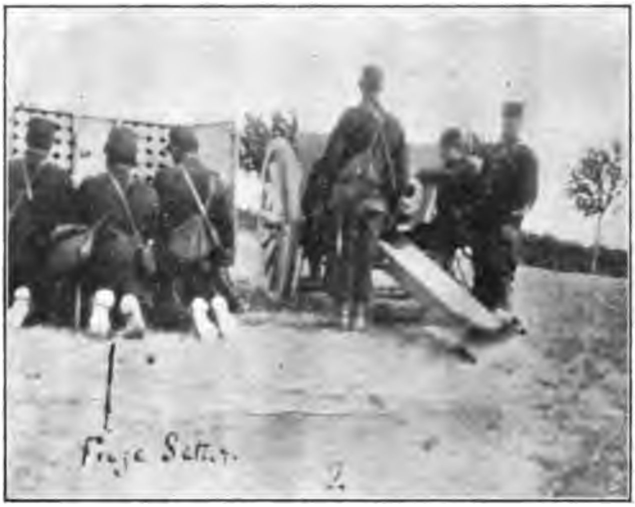


FIG. 2 French field gun in action. Rear view of gun and caisson showing positions of cannoneers.

3. Target presented.—The gun and caisson side by side present a wider but less deep target than when the limber is posted in rear of the gun. It is not believed that the wide target will be oftener hit than the deep one; it is unquestionably more visible in the open, but since it seems agreed that much of the firing in future will be indirect and means exist for shooting accurately by this method, and since effort will always be made to conceal the gun and its caisson and no smoke will betray it, the conclusion is fair that this objection is not sufficiently serious to outweigh any one of the advantages presented by the French method.

Again, with the limber (or caisson) in rear of the piece, there must be continual running backward and forward for ammunition, which not only exposes to fire those running but in many cases gives an indication of the position of the guns. A moving object is often visible where a larger stationary one is not.

4. Weight.—The weight of a bullet-proof steel bottom and doors for the caisson chest cannot be but a few pounds more than that of the structural iron plate of which they would in any case be made. I have not the means of making the exact comparison, but this can be done in a few minutes in the ordnance office. It would seem that 50 pounds is a large allowance for this difference.

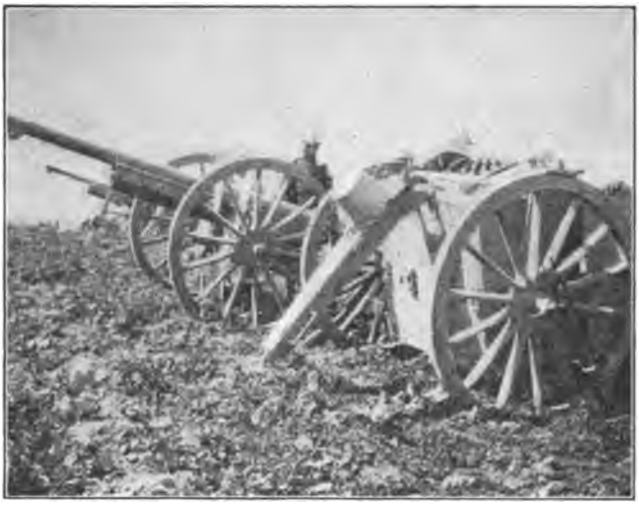


FIG. 3. French field gun in action. The bottom of the caisson and doors are armored; the gun has shields; all the cannoneers are thus protected from infantry fire coming from the front.

5. Danger from explosion.—The most serious objection that can be urged against the French system is the danger to the whole gun detachment and the piece in case a shell penetrates and explodes the caisson. Such a lucky shot would probably kill the whole detachment and disable the gun. What would happen in case a similar shot hit the limber under the English system?

The place of this limber cannot be fixed at much more than an average of 15 yards from the gun. Otherwise the men who bring up the cartridges would have too far to go, they would be exposed longer to fire, would be soon worn out by fatigue, and the ammunition, in an emergency requiring extreme rapidity of fire, would not be supplied fast enough. Would the explosion of a limber 15 or 20 yards away kill the gun detachment and disable the gun?

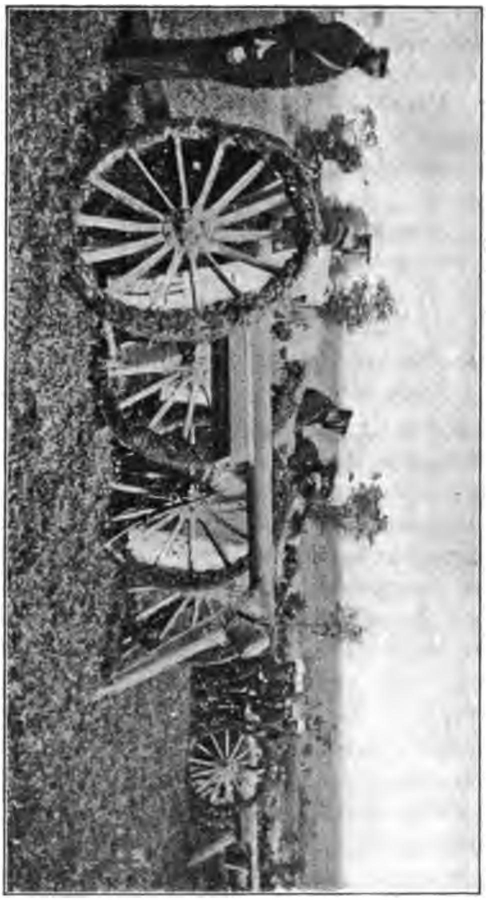


FIG. 4. French field artillery in action.

This crucial question I find myself unable to answer, but it should be answered, even if it be necessary to have an experiment to determine it. I hope that an opinion from experts on explosives may be obtained on this point. If their judgment is not final an experiment could be made at Sandy Hook, and the matter seems well worth settling.

With the caisson beside the gun, the men would all be killed: but it is hard for me to believe that with the caisson (or even limber) 15 yards in rear the same thing would not happen. Now it makes no difference whether a man be blown into a thousand pieces or two, he is merely killed in either case. As regards damage to the piece, however, the question is more complex and experiment alone could determine the damage in each case.

There can be little doubt that the French have carried out exhaustive trials to determine both this matter and that of visibility of target. It is wholly in accord with their methods of procedure to have done so, and while the results of these experiments are not obtainable, the fact that the artillery adopted the present arrangement of gun and caisson is an indication that they developed no fatal objection to the arrangement of placing them abreast.

6. Facility of maneuver.—The French system enables the battery to come into action and limber up more quickly than the English. This is due to the fact that in the latter the team must be unhitched from the limber or be exposed to extermination. If the horses are left hitched the size and visibility of the target are also materially increased.

If we suppose the limber to carry only about 30 rounds, when this is expended the limbers must be replaced by full ones. There is a great difference between the 30 rounds at hand in the limber using the old arrangement and the 72 rounds at hand in the caisson using the new. Moreover, when this first supply is exhausted the French system enables us to replace it more quickly than by the old arrangement. A full caisson comes up, unlimbers, drops the caisson body, limbers up to the empty one and moves off. To change limbers in the English system requires the team to be unhitched and hitched, which takes a little longer and the new supply of cartridges is much less.

Another point should not be forgotten in favor of the French arrangement. The shell travel point down as they should, but in action they lie on their side convenient for handling. In any system that does not revolve the caisson body 90 degrees on coming into action, it would seem that the shell must travel on their sides or else be inconveniently arranged for getting at and replacing.

If the limber (or caisson) is far enough in rear of the gun to protect the latter in case of explosion, one of two things must happen: either there will not be at the gun, under the very hands of the cannoneer who loads, enough cartridges for extreme rapid fire at any instant, or these cartridges must be brought up and stood in their carriers handy to the gun to provide for this emergency. Apart from their being unprotected from bullets while lying on the ground, the unused cartridges must be replaced before the battery can move off. This is a complication and a loss of time.

Now no one can predict when extreme rapid fire will be needed in an action and it should be easy to begin it at any instant and without any preparation. That is what the new gun is designed for. Sudden bursts or "squalls" of rapid fire followed by lulls seem to be the most effective method of using the rapid fire piece ; it is almost the habitual French method (fire by "rafales") and offers evident advantages. It seems, then, most desirable that the ammunition should be at hand ever ready for these "squalls" of rapid fire, and it cannot be ready with limber (or caissons) in rear of the guns except under the disadvantages just enumerated.

If we now glance rapidly back at this comparison, we will see that the system which places the caisson alongside the gun furnishes nearly complete protection without a man or horse moving from his place during a fight of 108 rounds, enables the teams to be put under cover without unhitching, offers a target a little more visible but not as vulnerable as the English system does, adds very slightly to the weight, permits of extreme rapidity of fire at any moment and without previous preparation, enables the battery to come into and withdraw from action a little more rapidly than if the teams are unhitched, and lays the battery liable to greater damage from an explosion of ammunition chests.

The only distinct advantage offered by the old system is the greater safety of the piece, and possibly part of the personnel, in case of explosion.

This advantage does not seem sufficiently great to compensate for all that is just in retaining the old formation. Indeed it would seem that in adopting the rapid-fir esystem we should go resolutely forward to the end desired, that of being able to fire at any instant suddenly and with enormous rapidity and accuracy.

The juxtaposition of gun and caisson and the protection afforded to all hands ensure these requirements and establish confidence and calmness. If the placing of shields on the gun, adding considerable weight as it does, is accepted as necessary the same reasons push us inevitably to the shielding of the other cannoneers, especially as it can be effected with less addition of weight than in the case of the gun shields.

There may be other systems that will accomplish this result, but none other known to the writer is so simple and effective as that devised by the French and none has received the test of five years' use by troops on a large scale.

We have followed the lead of the French in recognizing the necessity of quick-firing guns recoiling on their carriages and we have adopted a type and are now manufacturing the material. There seems no reason, then, why we should not go to the end and adopt also the French idea of an armored caisson and place it where it will be most useful. If we can devise something more effective, more ingenious and less dangerous, by all means let us get at it; but meantime the question should be stripped of all complexity and the really essential things alone kept in view.

What are these? We have a gun that in a pinch can fire 20 shots a minute. It is absolutely motionless once put in battery. The question is to get the best results from these qualities. What are the results we most want? We want to be able at any instant to use the rapid-fire qualities of the piece; we want to protect our men, horses and material.

The gun being motionless the ammunition can be put alongside of it, which was impossible as well as unnecessary with the old slow-firing piece running back 5 or 10 yards at each shot. To be able at any time to use a gust of rapid fire the cartridges must be at hand, not 3 or 4, but 10 or 20 of them. Therefore, put the cartridges near the gun where they can be quickly got at and passed from hand to hand, and where the fuze setter and the whole detachment are under the eye and voice of the gun-captain.

It being equally simple to place near the gun 72 catridges of the caisson chest as the 24 of the limber chest, let it be the caisson that is chosen and not the limber.

This point being decided, the question of protection comes next. Shields for the gun having been accepted as a necessity to protect those serving the piece, we must now see what can be done to protect those serving the ammunition. Their post being behind the caisson chest, the side of this chest toward the enemy can be made of bullet-proof steel with small addition of weight. But the chest, though very wide, is not two feet deep and affords little protection as it stands. Very well, revolve it till its widest surface is toward the enemy and armor this surface. Have the doors of steel and so arranged that when open they widen the protected space. We can thus easily shield three cannoneers.

The men being provided for, we take up the horses and extra caissons. Since we have 108 cartridges per piece with the guns, you can send the limbers and remaining caissons even as far as 200 or 300 yards to seek cover. A signal will bring them up in much less than a minute generally.

We thus have the teams under cover, the men well protected and a large supply of ammunition at the gun. If we are presented with the objection that the system is faulty because the blowing up of the caisson would destroy the whole detachment, we have an important question to resolve by reason and experiment. The reasoning is this: Suppose one hundred guns in action for four hours using the French system, how many caissons would be blown up. killing how many men? Suppose the same hundred guns with limbers (or caissons) 15 yards in rear in action for 4 hours, how many limbers would be blown up, killing how many men, and how many ammunition carriers would be killed while on their way from the guns to the ammunition chests? Are the losses in the two cases likely to be about equal? If the answer is yes, our decision need not be delayed.

What experiment must determine is whether a caisson blowing up 15 yards in rear of a gun will kill the men at the gun. If it does, then the caisson may as well be beside the gun as behind it.

This whole question is one of tactics and therefore one which the artillery should decide for itself. It should know what it wants and why; it should then ask the ordnance constructors to provide it. That they would gladly listen and be guided, there can be no doubt.

We have at this moment reached the point in our military development where our method of procedure in such matters must change or else we fix upon the new army, for perhaps another half century, the unintelligent and wasteful methods of the past.

These methods were the outgrowth of a condition of affairs discreditable to the artillery and in no way fortunate for the ordnance.

If a gun was needed, a sight, a rammer, a platform or any other implement, there has never been as far as I can learn, any body of artillery officers who were in a position to say—or sometimes even to know—what it was desired to accomplish, to what end or why. The ordnance officers had doubtless no better brains than the artillery, but they did have the habit of using those brains; they had, moreover, the tools, the money and the means of putting ideas into execution. The result was the ordnance got into the habit of providing (and with most loyal effort and industry combined, perhaps, with some contempt) everything that they thought the artillery ought to have. They did not always know what was best for us, but we appeared helpless to tell them; they gradually ceased even to consult us and we in revenge got the habit of believing that all they offered us to swallow was medicine and none of it jam.

This is happily no longer the case. We have now bodies of artillery officers whose opinions are worthy of the greatest respect. We have a vigorous chief who can present and support these opinions in the highest quarters. The artillery, therefore, can and should determine by earnest study and experiment what object is to be accomplished by each tool in its bag; it can and should clearly state what is wanted and why. The brilliant designers of the ordnance department will provide that tool and of the form and shape suited to the purpose in view. They cannot be expected to know all the details of our specialty as well as of their own. But we must study and try to foresee the problems of the future, keeping not only abreast of the times but a little ahead, and when we clearly see the thing it is important to accomplish, we should ask our brother workers of the ordnance to make us the implement needed.

It was exactly in this way that the French army produced the quick-firing field gun. As long ago as 1893-95 General Langlois, the brilliant author of "Les Enseignments des Deux Guerres Récentes," and then an instructor at the Ecole Supérieure de Guerre, at Paris, began to proclaim what the artillery must have and could have in the way of a weapon that would meet and distance the great improvements in the infantry rifle. He demanded a gun that could fire 20 to 30 aimed shots a minute, that could at intervals overwhelm and crush any troops that showed themselves with "rafales" (squalls, gusts) of shrapnel. Of course he was laughed at, called "Rafale Langlois," and all the rest that is usual in such cases.

But General Langlois never stopped his preaching until the right men as well as many men were convinced, and the French constructors were ordered to try to produce the weapon needed. How well they succeeded we all know, but the principle of the thing is as important as the fact. An unusually intelligent man with great foresight proclaimed what the artillery should have, to be equal to its future task ; an equally able constructor, Colonel Deport, produced the implement asked for. The present French field gun is that implement. It was demanded by a practical soldier and it was produced by a practical designer.

The artillery officers are not architects, they are tenants. They should say what purpose their house is to serve, how many rooms, how located and to what end. The ordnance officers are the architects who will draw the plans and build the house to fulfil its purposes.

This surely is the method of procedure which should now be followed in what concerns our new field gun. We have the piece and carriage, and most excellent they are. But the artillery should say what use they want to make of it, what sights they want for it, how placed for tactical reasons. They should say how the ammunition is to be supplied, where they want the caisson placed,—beside, behind or oblique : whether they want it armored or not, how much protection they deem necessary, and all the rest of it. The man who was brilliant enough to design the gun can be depended upon to resolve with equal ability the other problems presented to him. It is certainly too much to ask him to tell us what we ought to want.

CONCLUSION.

I now beg to resume the above argument in the following specific statements which I hope have been proved :

1. That whether the chest from which the first supply of cartridges is drawn be behind or beside the gun, this chest should be on the caisson body and not on the limber. A larger supply of ammunition is thus available and the team need not be unhitched in order to get under cover.

2. That the field gun provided with shields to protect the men serving the piece, should also have its caisson chest armored sufficiently to protect the men serving ammunition, and this whether the place of the caisson is beside or behind the gun.

3. That it is advantageous to armor the largest surface of the caisson and by revolution present that surface to the enemy. This saves weight as compared with adding a shield which does not at the same time serve as bottom, top or side.

4. That the position of the caisson alongside the gun has many advantages and no serious disadvantages except danger to the whole detachment in case of explosion. The extent of this disadvantage can only be determined by experiment.

THE DEVELOPMENT OF RECOIL AND COUNTER-RECOIL APPARATUS FOR LONG RECOIL FIELD GUNS.

From an article in "Kriegstechnische Zeitschrift"

BY J. CASTNER.

TRANSLATED AND COMPLETED BY PIORKOWSKI.

RECOIL IN GENERAL.

We call rapid-fire guns such whose recoil after firing is limited to a certain length by some kind of brake arrangement. Thereby part of the recoil energy is stored up in springs or other elastic bodies, and is used to return the gun after its recoil automatically into its firing position. In this way the work of the gun's crew to bring it back to battery is avoided and most of the time from one round to the next is saved, this being the essential condition for rapid firing. Special designs of the gun, its breech mechanism and its charge, which will allow quick opening, loading, closing and aiming, will add to make the gun quickly ready for the next round. Opinions, however, differ widely on the value of the several arrangements of this character, and their influence on the firing rapidity. We shall here speak only of the means of checking the recoil, all opinions agreeing on their necessity for the modern gun.

According to whether the gun alone or the carriage with the gun enter into the recoil, we have guns recoiling *on* the carriage or *with* the carriage, and call them for short, *long recoil* and *short recoil* guns.

RECOIL OF NAVAL AND COAST GUNS.

A checked recoil and automatic return was first used with small naval and coast guns, then successively with larger ones, and is now in use with all calibers. The technical solution of the problem was comparatively easy with naval and coast guns. Whilst for the smallest calibers a rigid connection of gun and carriage, and therefore a rigid transmission of the recoil shock to the carriage could be effected, for the larger guns it was preferable to receive the recoil by an elastic body, in order to reduce the strain on the carriage. In the first case the recoil was practically nil, in the other case it was limited to 3 to 4 calibers' length. In both cases the carriage had a tendency to run back or to rise in front and tip over backwards. But it could be fastened to the deck of the ship or masonry of the coast battery, and the difficulty was overcome.

RECOIL OF FIELD AND MOUNTAIN GUNS.

Conditions are different with field and mountain guns, where mobility is the first requirement, and where the carriage must not move back or jump or rise in front. This of course could easily be avoided by making the piece very heavy, because the length of recoil is in inverse proportion with the recoiling weight; but then the gun would result in being too heavy for transportation. Still this was the fundamental idea with short recoil guns. The total weight of gun and carriage recoiled, and the movement was checked by an elastic spur or spade, which digging itself into the ground, found its hold there. Whilst the carriage recoiled, it compressed a spring which automatically moved the gun forward again after the recoil was accomplished. In this way the short recoil, indeed, satisfied the requirements as stated above for checking the recoil of a rapid-fire gun, although differently than with naval and coast guns, where the gun alone recoils, sliding back in guides while the carriage remains in place. This last principle is the only rational one for all guns, field guns not excepted. The design of the short recoil field gun is to be considered as one adopted by necessity only as long as technical means failed to construct a field gun with long recoil that would fulfil the requirements of a rapid-fire gun of practical shape and weight for field service. The short recoil by elastic spur, therefore, was a temporary design to be abandoned as soon as a long recoil construction was successful in producing a field gun suitable in every respect. And this has been accomplished by all tests with the gun, which in its recent perfect design as a long recoil field gun, fills all requirements considerably better than even the best short recoil gun could.

FULL LENGTH AND SHORTENED RECOIL.

The construction of a long recoil gun has only been accomplished in recent years. True, a German patent on a long recoil arrangement for field guns (figure 1.) was granted to Grusonwerk as early as 1890, and to Mr. Röstel in 1892, but those were for guns with a "shortened" long recoil, which would never keep the carriage immovable during fire, as required for a modern rapid-fire gun. According to our knowledge and experience today, only a truly long recoil can perform this, a recoil of from 15 to 20 calibers' length; because the pressure received in firing by the recoil brake and the return spring is conveyed to the carriage. In order that the carriage may not yield to this pressure, that is to say, may neither move back nor jump or buck, but remain steady in its firing position, that pressure must needs be smaller than the resistance given by its weight and its friction on the ground. The resistance against recoiling is increased by a rigid spur below the trail. The tendency to jump or buck is diminished by a suitable distribution of the weight to be lifted, to which the length of the carriage from the point where the spur has its hold in the ground, gives leverage. The longer this lever, i. e., the gun carriage, the safer against jumping or bucking.

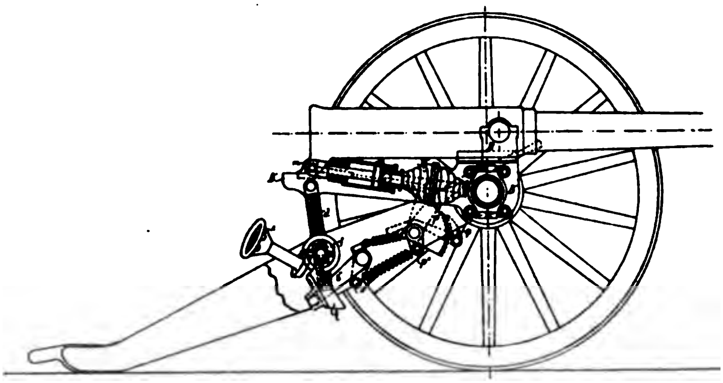


FIG. 1.

It results from these considerations that immobility of the gun while firing can be the more easily attained, the smaller the maximum resistance of the recoil brake and the return spring is. The resistance changes in inverse proportion with the length of recoil; the larger the recoil, the smaller the resistance; the recoil, therefore, ought to be made as long as the construction will allow. About 15 calibers is the proper length to secure the desired effect.

After these general remarks it will be interesting to show in what ways ordnance constructors have solved the problem of checking the recoil and automatically returning the gun to battery for different kinds of guns.

GENERAL ARRANGEMENT OF RECOIL BRAKES, AND COUNTER RECOIL.

It has been said above that the recoil brake must be connected with a counter-recoil mechanism, which receives part of the recoil shock and uses it for the return action. During the recoil this mechanism storing power, helps the brake to check the recoil. At first glance it would seem advantageous to unite both apparatus into one, for example, to let the same springs check the recoil by their compression and return the gun by their extension; but this is easily understood to be impractical. Hardly any of the recoil energy would be spent, but nearly all of it stored up in the springs; and given out again, would make the return as powerful as the recoil. Therefore, it is necessary to turn by far the greatest part of the energy during recoil into heat, and to separate the two actions. To check the recoil, the hydraulic brake has been given preference over all other brake constructions, because it allows regulation of the resistance so as to make it remain constant for the whole length of recoil. On the other hand the counter-recoil arrangements show a variety of designs.

RECOIL BRAKES AND COUNTER RECOIL WITH NAVAL AND COAST GUNS.

Signor Biancardi, now a general in the Italian army, as far back as 1871, proposed to connect the hydraulic brake with a pneumatic cylinder. The liquid would be pushed by the hydraulic piston through a valve, would enter a chamber filled with compressed air and cause a further compression by which, the recoil completed, the liquid would be forced back in its cylinder and return the gun to battery.

The rational and reliable action of this arrangement spoke in its favor. It was, however, very difficult to keep the stuffing boxes and valves tight, especially those of the pneumatic chamber, and particularly when not constantly under pressure, because then their faculty of keeping tight decreases. For this reason one or more columns of spiral springs gave a better counter recoil than pneumatic apparatus, the more so, as the manufacture of such springs made rapid progress as to their elasticity and safety against fracture, and a certain prejudice against the use of springs was overcome by the good results in practice. The use of springs for the counter recoil has the advantage of simplicity of construction, and springs are easily kept in condition. A disadvantage is their occupying more space, which has to be carefully accounted for in the construction of the gun carriage. Where a very light weight carriage is a necessity, the great weight of return springs also presents a difficulty. The Krupp Company used return springs up to largest caliber guns, but after carefully weighing advantages and disadvantages, changed the design of the largest naval gun carriage back to pneumatic return arrangement; not because the return spring had not proved equally good, but merely for reasons of weight and space. For turret guns especially, the direct combination of hydraulic brake with pneumatic cylinder, taking but little room, recommends itself. The greater mechanical complication and more difficult supervision, which demand an expert, are not as objectionable in this case, because they do not essentially add to the many complicated mechanical contrivances in connection with turrets, and there is no lack of mechanically trained men on board ship. With guns of medium caliber, which are more numerous on board than the large ones, the return springs have been retained; for with them the disadvantages of return springs and the advantages of pneumatic return are of less value. Also with heavy coast guns return springs are preferred because of their easy supervision, and because sand and dust will not affect them as much as in the case of more sensitive mechanisms.

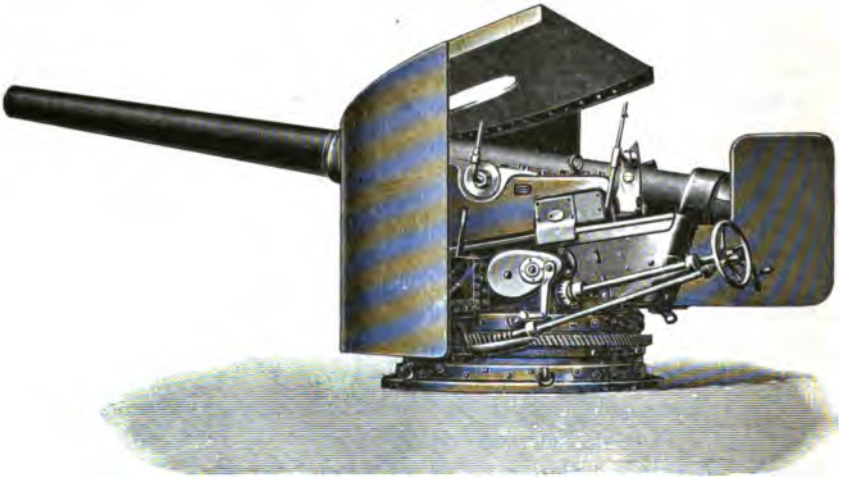


FIG. 2.

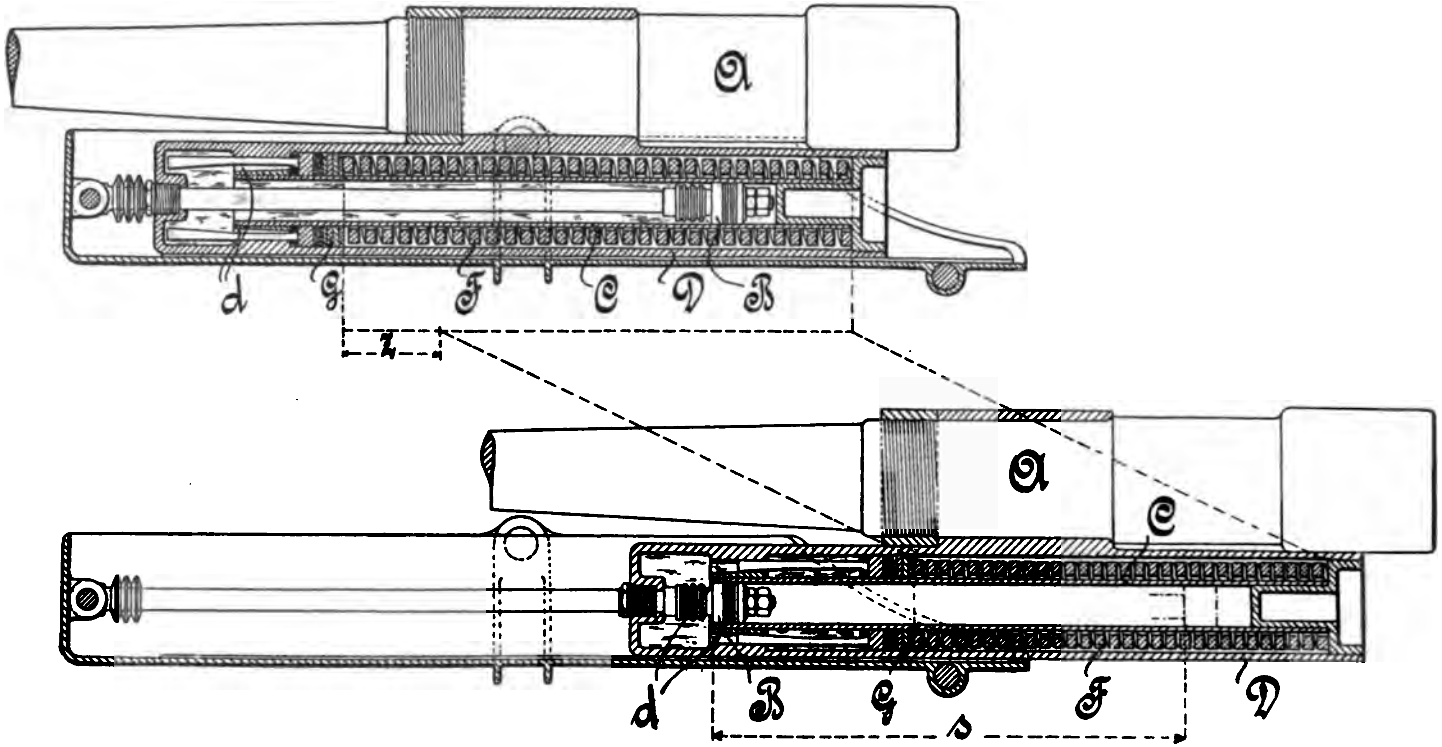
When in the middle of the eighties the Krupp works began the manufacture of rapid-fire naval guns, another way was chosen for automatic return, in order to avoid both the complicated pneumatic return and the spiral springs, which then were not sufficiently reliable. The gun was lodged by its trunions in a top carriage which recoiled on slides rising toward the rear, while hydraulic brakes checked the recoil (figure 2). The inclination of the slides toward the front makes the gun return automatically, directly after the recoil is ended. A special return mechanism was made unnecessary by this arrangement; yet it was given up in favor of the cradle design, which, beside other advantages, has the decisive one of allowing the gun sights to be fastened on the cradle which does not recoil, and so the aiming is made independent of the movement of the gun and its loading. The brake cylinders and spring housings are usually fixed with the cradle; brake cylinders and cradle are often cast in one piece; the piston-rods are fastened to the gun and join in the recoil. In this way the springs are compressed. But, as said above, the recoil with these guns is limited to from 3 to 4 calibers' length, and suitable and sufficiently reliable springs can be made made, even for the larger calibers.

LONG RECOIL AND COUNTER RECOIL WITH FIELD GUNS.

Things are different with a full length recoil which according to present experience is the only kind to keep a field gun immovable during fire. The technical solution of the problem at first failed, because the required return mechanism could not be found. Taking the caliber of 3 inches and 15 calibers for the recoil, gives 45 inches. A spiral spring capable of being compressed so much was considered impossible, without making it longer than could be allowed with a field gun. For this reason probably, Herr Hausner, who took out a German patent in April, 1891, (the first patent with this object) conceived the idea of using a pneumatic return with a long recoil field gun. The arrangement consisted of two tubes, one within the other, the inner one containing the liquid. The gun recoiling pulled out the piston and the outer cylinder caused attenuation of the air in it, by which the gun was supposed to return. It is not known whether the idea has ever been tried.

Another proposition of Hausner's, patented in 1896, and assigned to the "Fahrzeugfabrik, Eisenach, Germany," in 1901, might be considered a forerunner of the long recoil of modern field guns. There are two spiral springs one inside the other, wound in opposite directions, guided in a tube which is lodged within a space in the tubular body of the carriage. The gun recoiling would compress the return springs by means of a rope and pulley. The hydraulic brake was fastened in a trough-like guide which served as a cradle to the gun.

The design resembles one by Thronsen (Finspong) of 1896, (See Wille, Schnellfeuerfeldkanonen, I. Teil, Berlin, 1899, page 152) where the hydraulic brake and the return spring lie in the body of the carriage, one behind the other and are worked by



FIGS. 3 and 4.

chain and pulley. But Thronson produced only a short recoil, Hausner's design allowed long recoil.

Compression of the return springs by rope and pulley is inferior to direct compression, nor can the chain and pulley for the same purpose be recommended. Nor is it good to place the return spring inside the carriage, which makes a direct compression by the recoiling gun impossible.

For a long time after these first attempts it seemed indeed as if unsurmountable difficulties met a return spring for long recoil with direct action. This is probably why the French field gun, model 1897, whose construction then was near completion, received the very complicated hydro-pneumatic recoil mechanism, although even then it was severely criticised by nearly every expert. It has three cylinders, two with pistons for the hydraulic brake, the third serving as air compressor for the return. This apparatus has four stuffing boxes, one ball valve and six cylinder covers packed and screwed on, all being weak spots, easy causes for disturbance, as the vibrations in firing or on the march interfere with the packings. It is very natural that this French design has not been imitated.

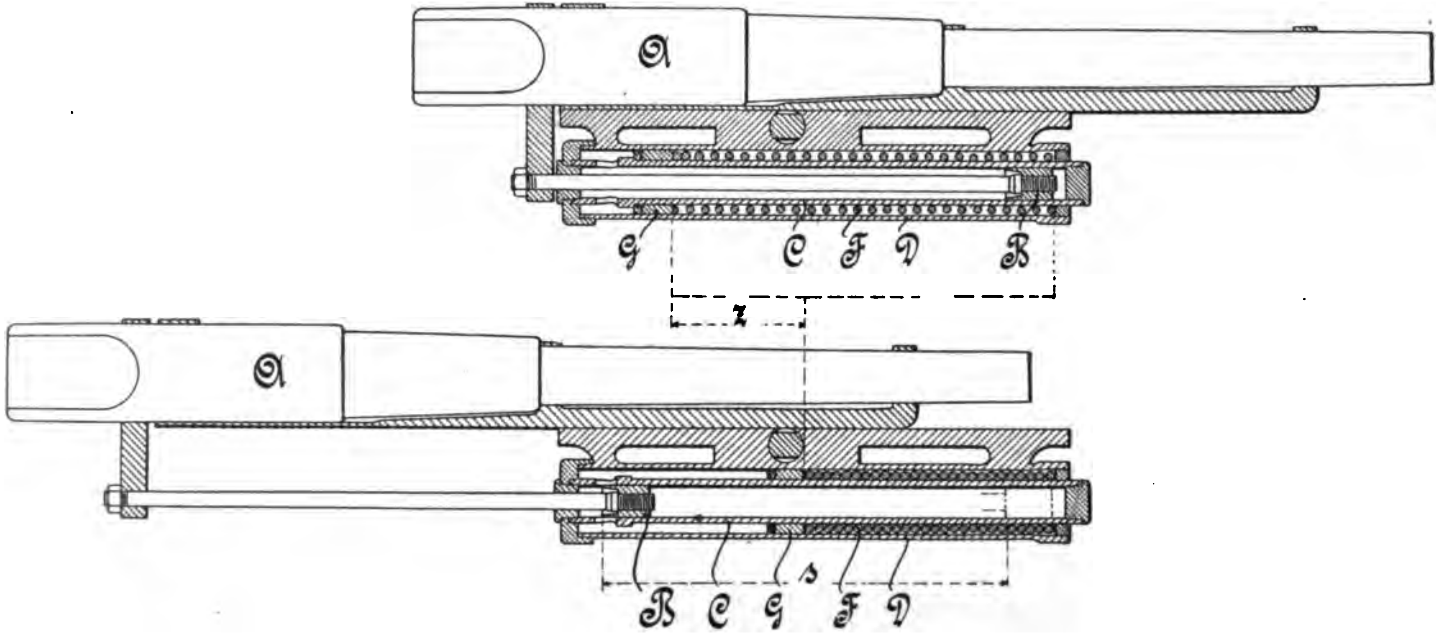
Constructors found a way out of the difficulty. They made the spring perform the return, but made the length of compression shorter than the length of recoil of the gun. This of course can only be done by transmission, which, even at the best, will complicate the arrangement and make it more sensitive, than when the spring is compressed direct. The following examples will show it;

SKODA'S FIRST DESIGN.

(German patent No. 77047 of Dec. 28, '93. Fig. 3 and 4.)

In this construction brake cylinder **C** and return cylinder **D** which envelops return spring **F**, recoil with the gun **A**, while brake piston **B** fixed on the cradle remains in place. The liquid, during recoil, is forced through openings **d** from the brake cylinder into the return cylinder **D** and moves the ring-shaped piston **G**, which acts on the return spring and compresses it. As, however, the effective active area of the annular piston **G** is five times as great as that of the brake piston, the shortening of the spring amounts to only $\frac{1}{5}$ of the length of recoil, say $\frac{s}{z} = \frac{5}{1}$.

Skoda uses hydraulic transmission because of his opinion, stated in the patent, that a cylindrical spiral spring ought not to be compressed more than ¼ of its free length to avoid over-



FIGS. 5 and 6.

strain, so that with a length of compression = s the length of the spring ought at least to be = 4s.

DRIGGS' DESIGN.

(U.S. patent 682585 of Sept. 10, 1901, Fig. 5 and 6.)

Driggs presumably starts from the same supposition. His design practically only differs from Skoda's in so far as the brake piston **B** alone joins in the recoil. The effective area of the return piston **H** is only three times that of the brake piston **B**, so that $\frac{s}{z} = \frac{3}{1}$.

VICKERS' FIRST DESIGN.

(British patent 9181 of the year 1901, Fig. 7 and 8.)

This construction shows the strongest ratio of transmission of all. It is 7 to 1, and consequently puts the lowest strain on the return spring. In every other respect the action is so similar to the foregoing one, that a description is unnecessary.

RÖSTEL'S DESIGN.

(German patent 94012 of November 24, 1896, Fig. 9 and 10.)

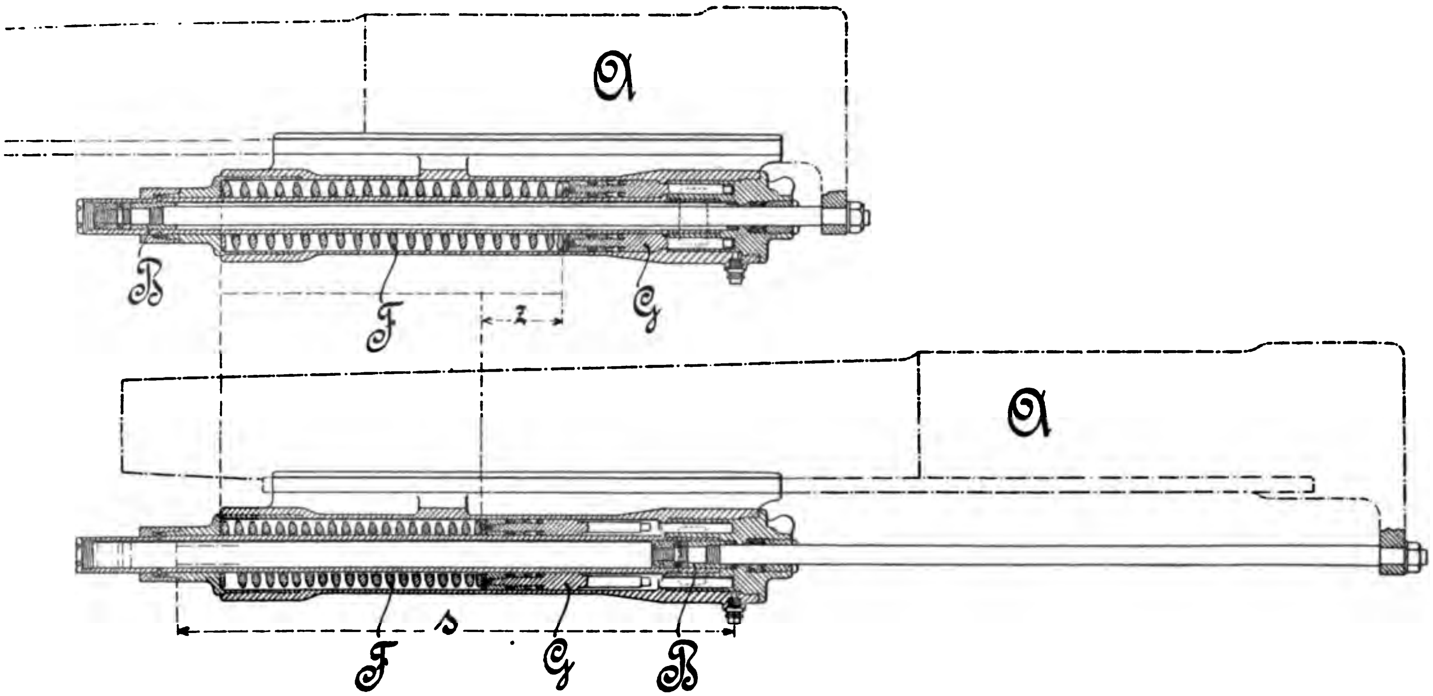
This design is peculiar because the return springs are lodged in the hollow axle **D** of the carriage wheels. Through the channels **c** the liquid from the brake cylinder **C** is forced against the return pistons **E** by which the two columns of Belleville springs **F** (the figures show only half of the return mechanism) are compressed against fixed disks. The brake piston **B** and its rod only take part in the recoil. The proportion between the pistons **B** and **E** is = 1 : 3, therefore the piston **B** recoiling and driving the liquid from cylinder **C** through channels **c**, between the two return pistons **E**, compresses either of the two columns of springs for $\frac{1}{6}$ of the length of recoil; so $\frac{s}{z} = \frac{6}{1}$.

Among all the known recoil mechanisms this one is by far the most complicated. The many packings make it very sensitive, and placing the return apparatus in the axle adds to the sensitiveness because, when driving, the axle receives all the shocks and vibrations direct.

KRUPP'S OLDER DESIGN.

(German patent 108095 of February 6, 1899, Fig. 11 and 12.)

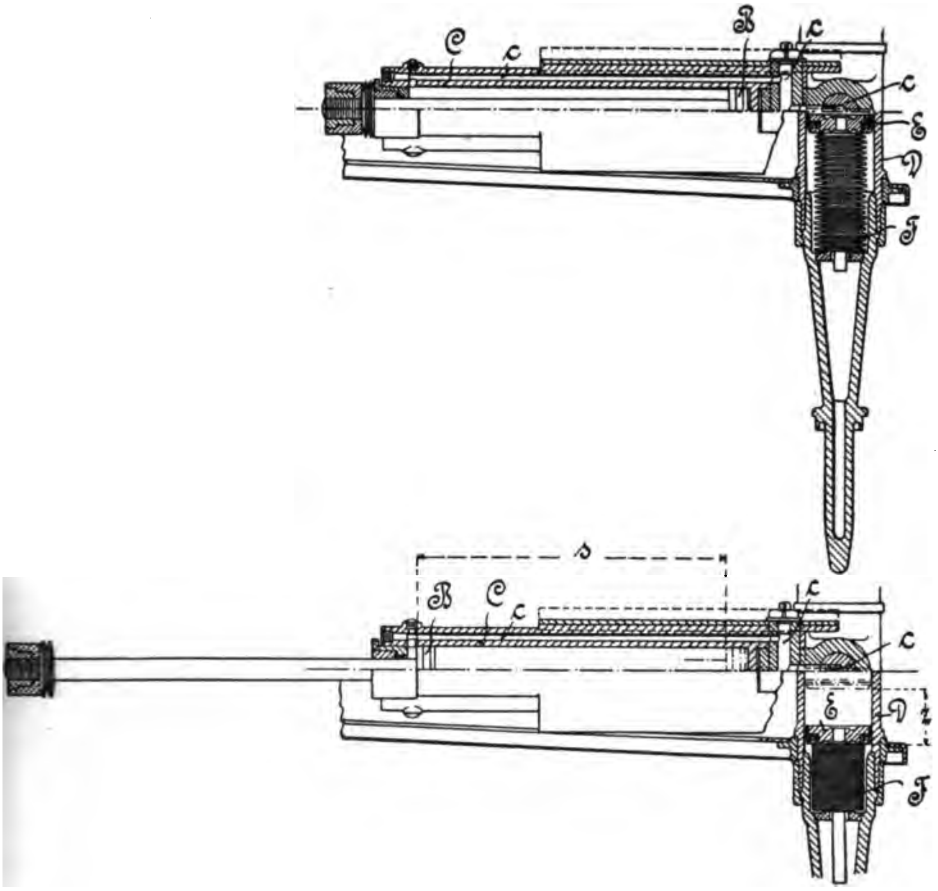
This construction is distinguished by transmitting the recoil to the return mechanism by means of rope and pulley. This is done in the following way. The gun **A** recoiling carries back the brake piston **B** and also, by means of two ropes **C** fixed right



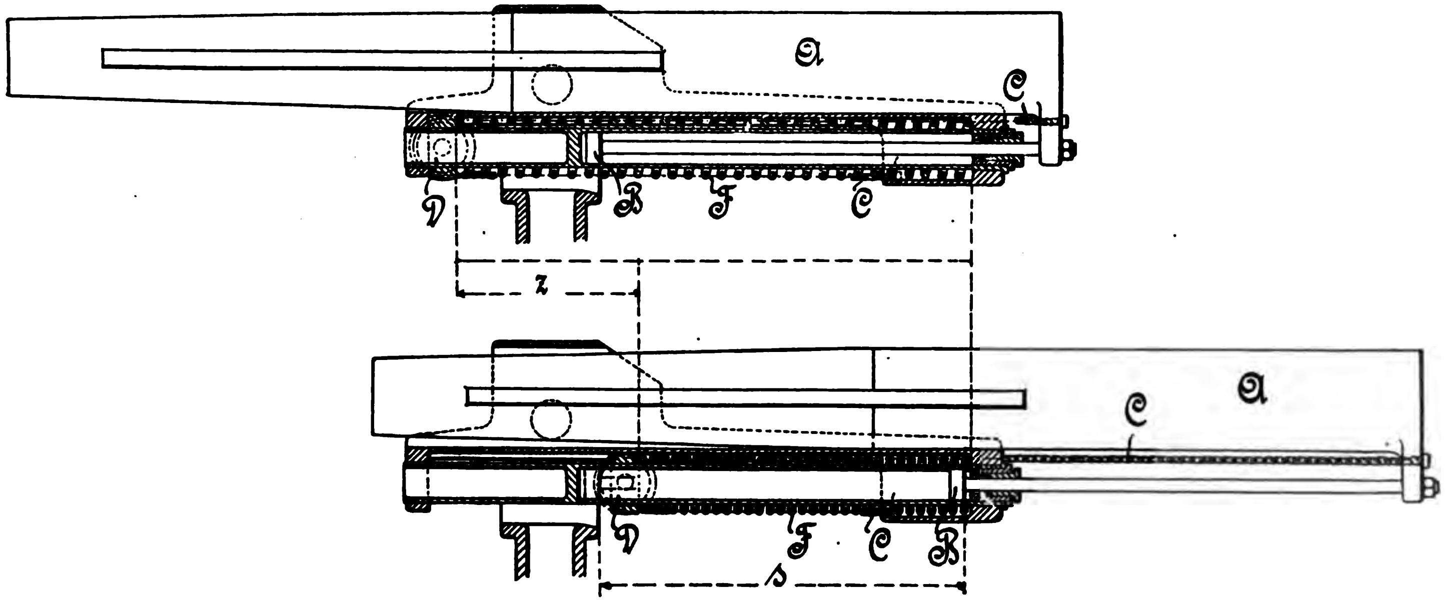
Figs. 7 and 8.

and left of the piston, the pulley-bearer D which compresses the return spring. As the pulleys roll on the lower steady ends of the ropes, they travel only half the length of recoil, so here $\frac{s}{z} = \frac{2}{1}$.

Even the Krupp factory formerly shared the opinion that with a long recoil it was necessary to make the compression of the return springs shorter, as appears from the wording of the patent, where it says: "If the recoil is very long, very long springs will be required, because their compression is of limited length. It would be difficult to place these long springs on the carriage and their weight and that of their supports would add considerably to the weight of the gun." Relatively simple as the transmis-

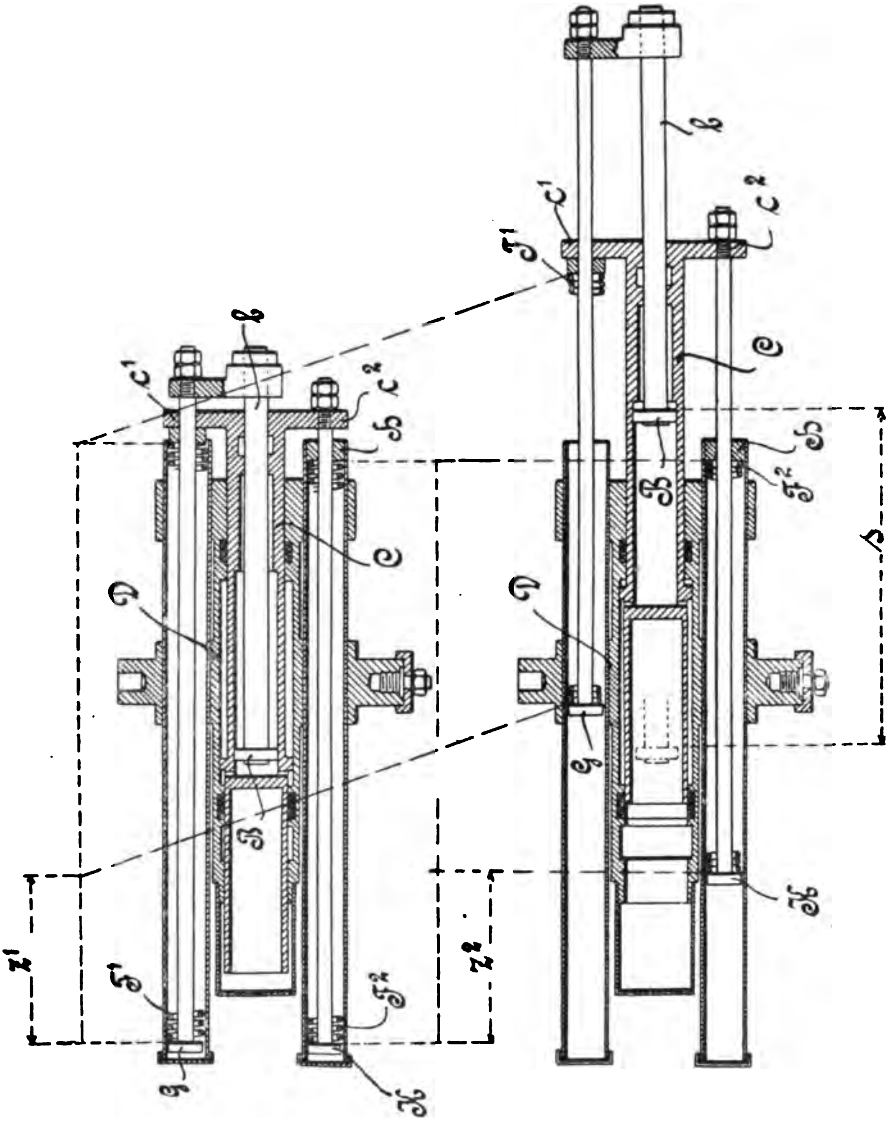


FIGS. 9 and 10.



FIGS. 11 and 12.

sion by rope and pulley appears, it is inferior to the direct action of the recoil spring.



FIGS. 13 and 14.

SCHNEIDER-CANET'S DESIGN.

(Figure 13 and 14.)

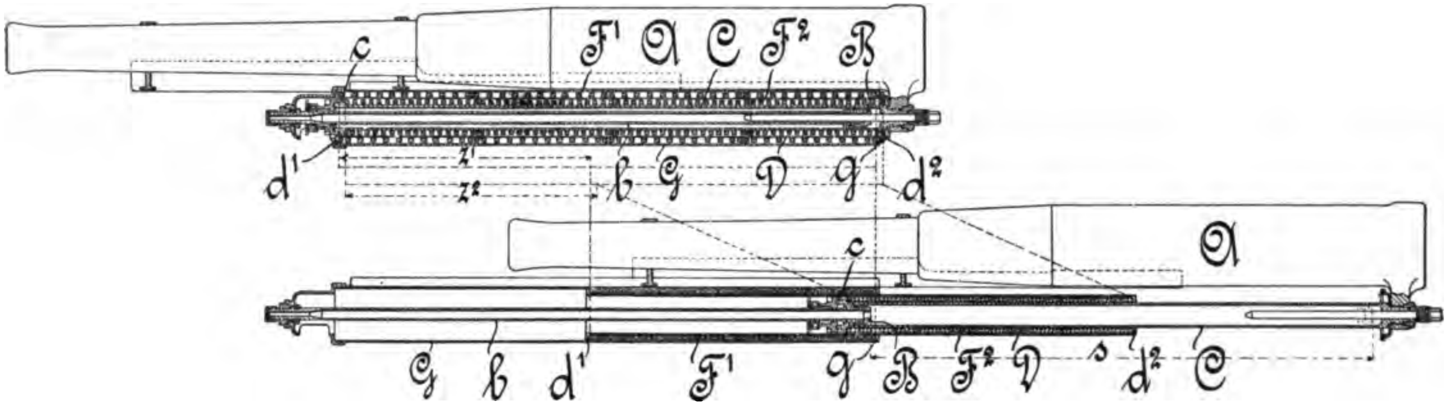
This French construction differing from all described above, (see Engineering No. 1792, page 576) has two columns of springs placed at both sides of the brake cylinder. From the telescopic brake cylinder the recoil is transmitted by means of crossbars to the return springs in such manner that each spring is compressed by half of the recoil. This is done as follows: Rod **b** brake piston **B**, and the rod fixed to the support **G** of spring F^1 are fixed to the gun and recoil with it. Brake cylinder **C** pulls out of cylinder **D** containing the liquid; it carries at its outer end a crossbar which at c^1 forms the retainer of spring F^1, and at c^2 holds the rod whose piston **K** compresses the other spring F^2. The other end of this spring is supported by the fixed end of its cylinder **H**. When the gun recoils brake piston **B** and support **G**, compressing spring F^1, recoil with it, until **B** knocks against the shoulder of brake cylinder **C** when it carries **C** with it and pulls it out of cylinder **D**. At the same time piston **K** begins to move and compresses spring F^2, while spring F^1 keeps the compression it has obtained, when spring F^2 begins to be compressed. Each spring therefore is compressed by half the recoil, $\frac{s}{z} = \frac{2}{1}$.

The arrangement is rather awkward, the use of two columns of springs and the crossbars for transmission make it complicated and heavy.

ARMSTRONG'S DESIGN.

(British patent No. 17176 of 1900, Fig. 15 and 16.)

This construction has two cylinders, one in the other, both surrounded by a column of springs. Each column is compressed for half the length of the recoil, when the cylinders are drawn out, because the hollow rod **b** of the brake piston **B** is fixed to the head of the cradle **G**, and the brake cylinder **C** is fixed to the gun **A**. When the gun recoils, brake cylinder **C** goes with it, and the inner spring F^2, retained by shoulder **c** of the brake-cylinder in front, and supported by an inner flange d^2 of the tube **D** in the rear, is pulled with this tube out of the cradle. The outer spring F^1 is compressed by a flange d^1 at the front end of tube **D**; flange d^1 and retaining ring **g** for the rear end of the spring F^1 serve as guides to tube **D**, and so **D** being pulled out, F^1 is compressed also; so both springs are set simultaneously and equally, as long as they are of equal strength. In case their strength is not even, the compression is equalized by jerks until at the end of the recoil each spring will be set for one half of the recoil. The return will show the same action in reversed order.



FIGS. 15 and 16.

VICKER'S SECOND DESIGN.

(British patent No. 9181 of 1901, Fig. 17 and 18.)

This mechanism comprises a hydraulic brake and two return spring arrangements at both sides of it. The return apparatus are arranged very much like Armstrong's, each having double springs with tubes, pulled out and compressed for action in similar manner. As shown in the drawing, a special rod is necessary to set the springs ; these rods are fixed to the gun and have a collar **b** which compresses the inner spring.

The use of two compressors independent of the hydraulic brake and 4 columns of springs in all appears as a baokward step from Armstrong's construction, only justifiable in case the two columns of springs failed to do the work satisfactorily, to return the gun to battery.

SKODA'S SECOND DESIGN.

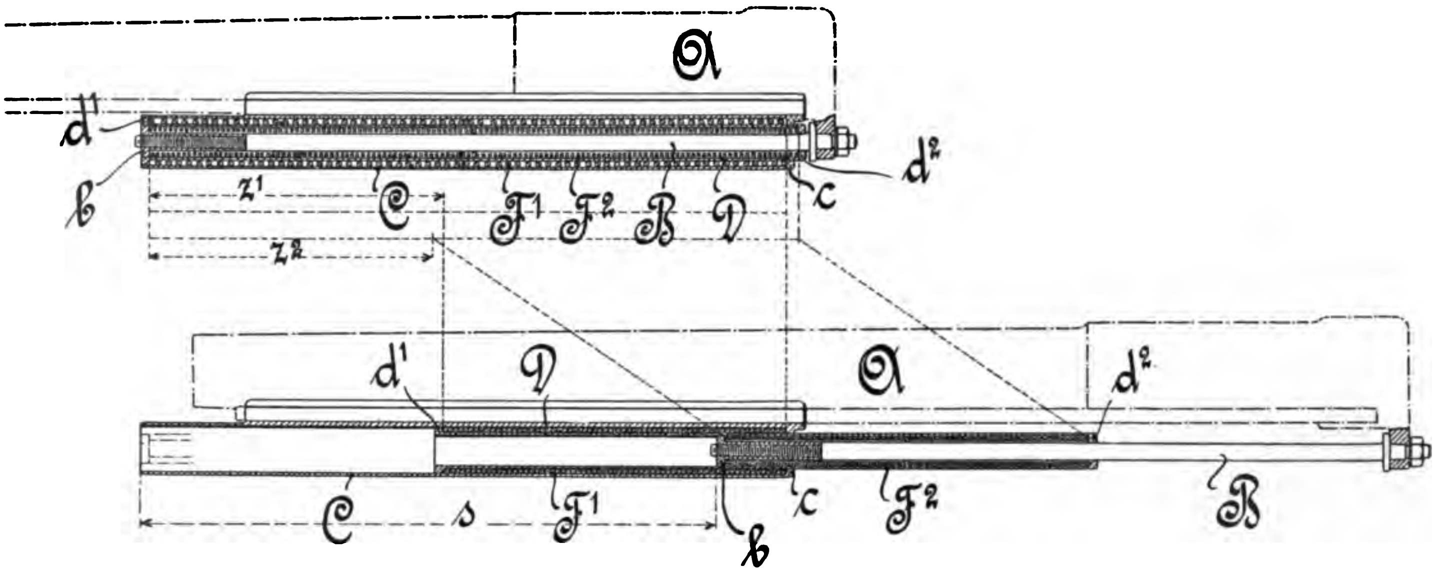
(British patent No. 24838 of 1901. Fig. 19 and 20.)

This construction is totally different from Skoda's first, following more the plans of Armstrong and Vickers, like these making the compression of the springs ½ as long as the recoil. As with Armstrong's construction, the hydraulic brake and the return mechanism form one system, the inner return spring surrounding the brake cylinder. The drawing shows that the brake cylinder **c** is attached in front to the cradle **g** ; the telescopic tube **D**, at the bottom of which the brake rod **b** is fixed, is attached to the gun **A**. This tube **D** therefore follows the recoil, and the spring is set in the same manner as in Armstrong's construction.

NORDENFELDT-TERNSTRÖM'S DESIGN.

(British patent No. 6426 of 1902. Figs. 21, 22 and 23.)

This construction is similar to that of Vickers', for it has a double return mechanism at both sides of the hydraulic brake. Each return cylinder **C** contains two springs, one inside the other, wound in opposite directions. The inner spring **F**^{1} is hooked on to the gun **A**. The same hook also holds the rear end of the spring, whose front end is held by the piston **D**, and this piston slides in the cylinder **C**. The front end of the outer spring **F**^{2} is supported by the flange of the piston, its rear end is retained by cover **E** of cylinder **C**. The gun recoiling, carries with it the hook of the spring, while brake cylinder and return cylinder are held in place by the cradle, extending the inner and compressing the outer spring. The extension of one and the compression of the other must give a summary length of set-



Figs. 17 and 18.

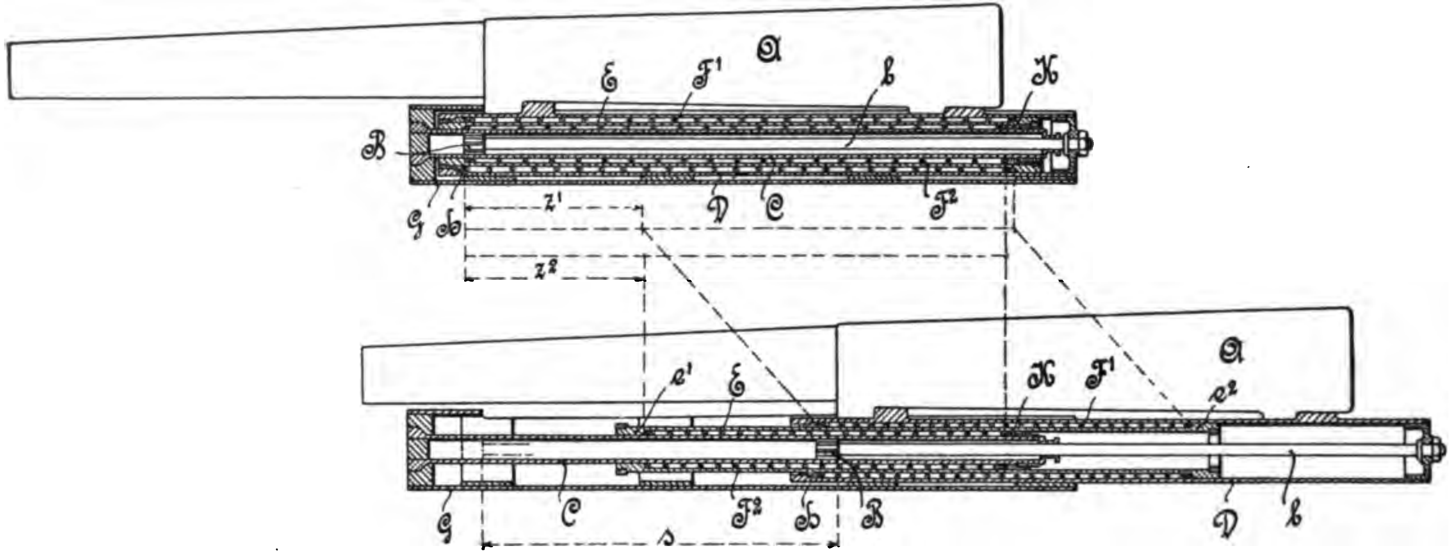
ting, equal to the length of recoil; whether this length is equally divided between the springs depends on the resistance against extension of the one being equal to that against compression of the other. The spring which will offer less resistance will be strained more. This construction shows the curious case that one spring, the inner one, is set by extension.

EHRHARDT'S DESIGN. (Figs. 24 and 25.)

This design has been applied to the so called "Ehrhardt guns" manufactured by the "Rheinische Metallwaaren & Maschinenfabrik Düsseldorf", but recently has been considerably modified. The design shown in the present drawing was described in "Mittheilungen über Gegenstände des Artillerie- und Geniewesens" 1901, No. 3. There the cradle, containing the brake and return mechanism, protrudes beyond the breech of the gun in a way evidently interfering considerably with the service of the gun. The designer seems to have made this sacrifice to uphold his principle, correct in itself, to let the recoil work direct on compressing the spring, holding that springs compressible for the full length of recoil could be made. In this respect the above named article says (page 234), "The springs are arranged in two layers, one inside the other. One spring alone to render the necessary resistance, would have to be stronger; with the same length of the spring its allowable compression would be shorter, and so necessarily would have been the recoil. By using two springs and their summary resistance, each one could be thinner, and they could with equal length be compressed for a greater length."

Adhering to this opinion regarding the compressibility of spiral springs for a certain efficiency, it results that another way had to be found to provide the same efficiency of the springs with a shorter cradle and a shorter recoil and counter-recoil mechanism, that would not inconvenience the loading of the gun by standing out beyond its breech end. For this reason, Ehrhardt, with his later guns, where the brake has its end at the breech of the gun, uses four spiral springs, one in the other, alternately wound to the right and to the left. To make the shorter springs capable of the same effect, their number had to be doubled.

The action of the mechanism is clearly shown in the drawing. Brake cylinder **B**, which is guide for the return springs, is screwed on to the front ring **a** of the gun **A**, its other end slides in the bottom of the cradle **E**. The front plate of the cradle holds the piston rod by means of a nut. The return springs bear against



Figs. 19 and 20.

the rear plate of the cradle and the stay ring **a** of the gun. So the recoil of the gun will compress the springs and moves the brake cylinder back from the cradle. Ring **a** of the gun slides in the open top of the cradle whose upper edges, bent inside, form guides for the recoiling gun.

It seems that fear,—one or the other springs might break with the long compression, and the fractured ends might interfere with the other spring and make the return apparatus unserviceable,—caused the constructor to divide each spring into four short pieces and separate these by I-shaped rings, so as to localize the consequences of a fracture and facilitate exchange of broken spring.

KRUPP'S NEW DESIGN. (Fig. 26 and 27.)

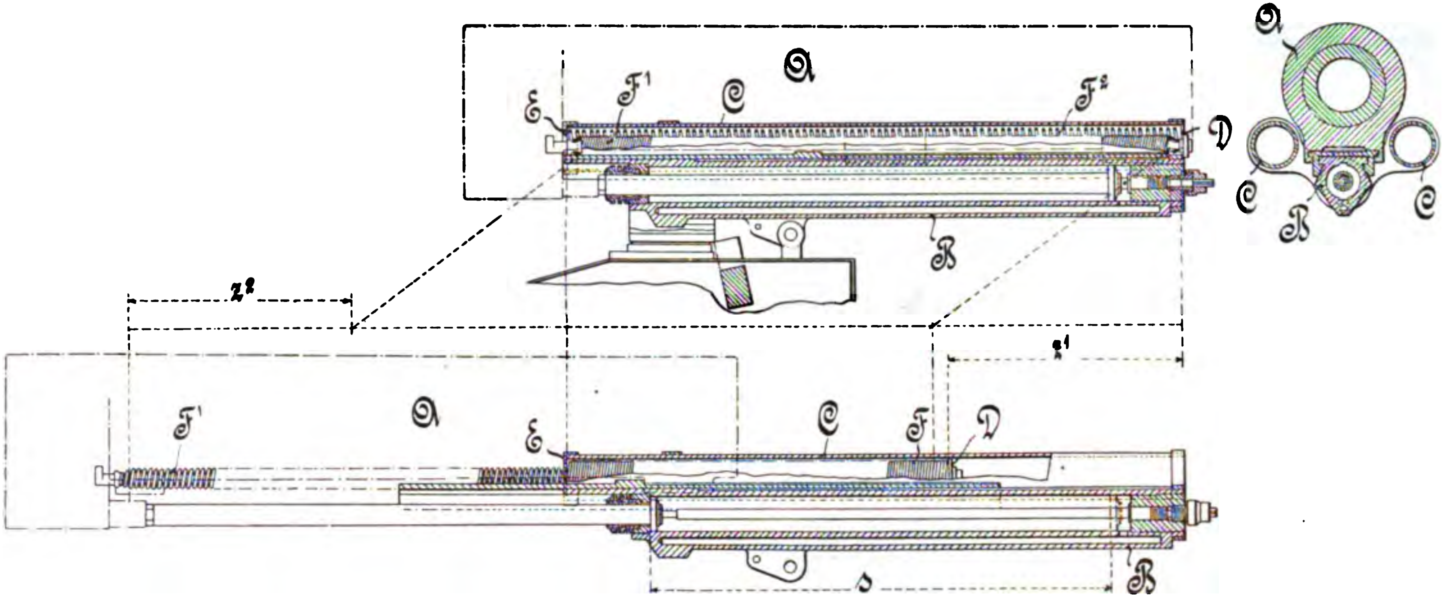
This construction of the recoil brake with return spring for long recoil was first published in "Revue Militaire Suisse", November, 1901.

All constructors until then believed that with a long recoil the gun could not run into battery by direct action of one column of springs, so that the length of setting was equal to the length of recoil, $\frac{s}{z} = \frac{1}{1}$. Contrary to this belief this construction proves the solution of this problem was possible, and it has shown itself perfectly reliable in practice. How the task is accomplished is easily seen in the drawing. The brake piston rod is held in the head of the cradle by a nut, the brake cylinder is fixed to a lug at the breech of the gun. The spiral spring, of flattened wire, surrounding the cylinder is retained by the bottom of the cradle in the rear and compressed by a collar on the brake cylinder in front. The recoiling gun pulling the cylinder back through the rear plate of the cradle, compresses the spring. There is no transmission, and recoil and compression are of equal length.

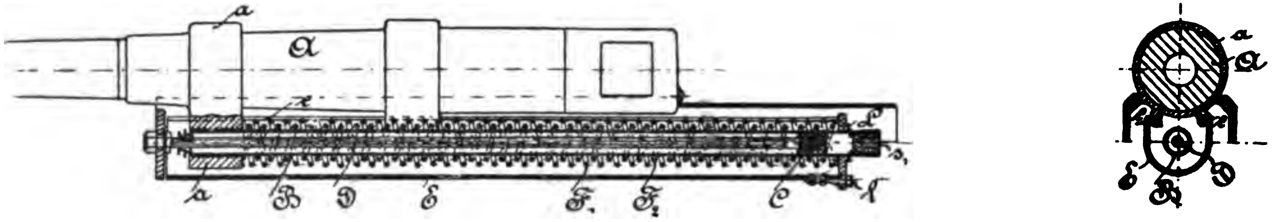
FINAL REMARKS.

For naval and coast guns the shortened recoil of the gun on the carriage is adopted everywhere. According to present ideas and existing conditions, a change within a given time seems improbable. The hydraulic brakes and the automatic return for these guns have in their development reached technical perfection to such a degree that no improvement of importance has been made in the last years. Long recoil for field guns, on the other hand, has only been developed in these last years, and so the following remarks are limited to such guns.

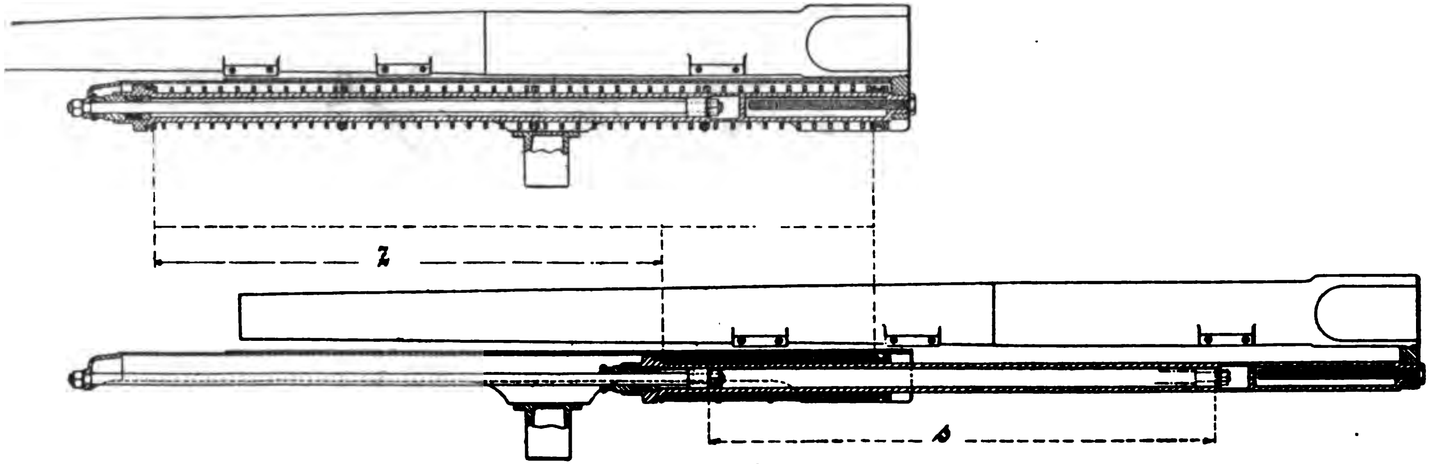
The succession of designs of recoil brakes for long recoil and automatic return apparatus, described above, shows that perfec-



Figs. 21, 22 and 23.



Figs. 24 and 25.



Figs. 26 and 27.

tion was reached at last by a mechanism, where one column of springs was compressed, and set direct and without transmission, by the recoiling gun for the full length of recoil. This construction must be designated as perfect, because, mechanically speaking, nothing simpler can be thought of, and in practical use the simplest device is the safest against disturbance in its action and the least sensitive ; it therefore requires the least care in using and handling ; because of its simplicity the construction is of the smallest weight, increasing facility of transportation, and—last, not least—can be made at the smallest cost.

Of all designs known, only the last described above, fulfils the requirements of the simplest and perfect construction as here characterized.

The advantages of field guns keeping their position whilst firing is easily demonstrated in theory. It is therefore to be presumed that ordnance engineers recognized them when they began to plan rapid-firing guns ; the more so, as for the last ten years prominent constructors have racked their brains to transfer these theoretical advantages into practice. The development of their results proves once more the old experience, that the practical form of great ideas progresses toward simplicity, and the very best is often so startlingly simple, that the uninitiated thinks there is no invention at all in it. The expert, however, judges from the course of development.

In this case the constructors all started from the assumption, deemed inscrutable, that one column of springs of allowable length and sufficient strength to take the strain and do the work, could not be compressed for the total length of recoil. Most of them tried to get round the difficulty by shortening the setting of the springs by means of mechanical transmission.

Skoda, Driggs, Vickers and Röstel tried hydraulic transmission, but arrived at more or less complicated constructions with a number of packings hard to reach, and very sensitive to the vibrations in field guns in transportation. This is especially true of Röstel's design. The more complicated a mechanism, the more vulnerable it is.

Relatively simple is the transmission by rope and pulley in Krupp's older design, much in contrast with the evident awkwardness and eomplexity of Schneider-Canet's, which moreover adds much weight to the piece.

Armstrong, Vickers and Skoda then use several layers of springs with telescopic tubes, separating the springs, so that a broken spring would not interfere with its neighbor. Ehrhardt tries to do without the tubes, only he has his springs wound in opposite directions and risks the probability of such interference. The shorter setting of the springs by pulling the spring tubes out like a telescope requires very careful manufacture to make the resistance of the springs equal, and assumes that they will not change with use. It is questionable whether this requirement can be filled satisfactorily.

An astonishing arrangement, and contrary to common usage is the setting of the inner spring by extending it, as in Nordenfeldt-Ternström's construction. Experience teaches that springs compressed to react by extension, guided on a spindle, when broken but else in good condition, will not usually interrupt the function, but occasionally allow its continuation for some time. But when an extended spring, reacting by contraction, breaks, it cannot serve any longer.

Nordenfeldt-Ternström and Vickers have four columns of springs in two return apparatus. That is too much of a good thing.

The whole succession of designs proves that up to this point nobody realized the possibility of transfering the long recoil direct onto a single spring. The last described construction by the Krupp Company evidences this possibility. The leading idea of this construction is the happy choice of a cross section of the spring which unites sufficient strength and compressibility.

There is no more necessity for a transmission between recoil and counter recoil, or doubling the number of springs to store up sufficient energy. And so the Krupp design presents a new principle above the conventional constructions, with the advantage of unequalled simplicity, very much like Columbus' egg.

The new United States field gun has practically the same arrangement as Krupp's gun. That is to say, the brake cylinder is attached to a lug at the rear end of the breech of the gun, the piston rod is fastened to the front cap of the cradle. The return spring surrounding the cylinder, and having the cross section of a flattened wire, is supported against the rear plate of the cradle and compressed by a ring on the front end of the cylinder. There is a buffer arrangement in the apparatus which softens the return to battery: the piston rod is hollow and in it moves the buffer piston which with the cylinder is attached to the rear end of the gun. The recoiling gun draws the brake cylinder and the buffer piston back, and thereby sets the counter-recoil spring. The recoil ended, the spring will extend and return the gun to battery, which movement is softened by the buffer piston moving inside the hollow brake piston rod.

It remains an open question if the benefit derived from the buffer will be sufficient to recommend the complication added.

In conclusion it may be stated that the effective development of the long recoil field carriage only began after 1897, when France had adoped her model of 97. Only after that time was it made serviceable for war and answered all requirements. By this fact those men are justified, who then hesitated to offer a long recoil design, because it was not ready, and who, in their reserve, undisturbed by current opinions, quietly worked on until perfection was attained.

* * *

NEW FORMS OF ARMORED FORTS.

By VICTOR TILSCHKERT, Colonel in the Austro-Hungarian Army.

Translated from the German* by Major John P. Wisser, Artillery Corps

II.

As shown in the figures, each gun is supposed to be mounted in an isolated armored turret, placed behind an earthen parapet, secure against direct assault. Guns and howitzers are always so elevated as to enable the gunners to see their targets, and to direct their fire on the latter without further assistance. But this is not possible for the low-lying mortar cupolas, and these pieces must therefore obtain the azimuth and range of the target from without, that is, from an observation cupola or from one of the gun cupolas.

For this reason every group of about 4 mortars has a high observation cupola attached, which transmits the necessary data to the mortars by telegraph, telephone, telautograph, ordinary signalling, megaphone or simple word of mouth, or by messengers (a man requires 20 seconds to go to the farthest mortar, assuming that the observation stand is in the center of the group, and the distance between turrets or cupolas is 22 yards) ; or one or perhaps two mortars may be attached laterally to a gun or howitzer turret, as shown in fig. 2. For this purpose the adjoining corner pieces of the turrets receive at the lower tier the necessary form with flanges for fastening them together and forming a short connecting gallery. The flanges, visible on the outside, are made so strong that projectiles striking them will be shattered.

As soon as the gun is pointed at the target of the mortar, the azimuth for the latter is given, resulting as it does when from the azimuth of the target from the gun turret, we subtract the angle at the target included between gun and mortar. The range of the target and the distance between gun and mortar will determine the angle, and this must be calculated and entered in tables for all azimuths and for ranges differing by 100 yards, for ready use without calculations.

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* Neue Formen der Panzer-Fortification. Von Victor Tilschkert, k. u. k. Oberst. Wien: L. W. Seidel & Sohn. 1902. Price 3 marks (90 cents with postage.)

Fig. 2 shows two mortar cupolas combined with the armored gun turret; the cupolas are about 20 feet apart. Although this location of them facilitates fire control and direction (especially at close range), as well as the supervision and supply of the men, it nevertheless has the disadvantage (which must not be underrated) that, in case of a bombardment of the gun turret by means of high-explosive shell, the shots which miss the gun turret may hit the mortar cupola, which with an interval ot 65 to 100 feet between cupolas would be very improbable. The tendency will therefore be to separate rather than combine the turrets, and, if it is decided to combine them, to limit the combination to but one mortar.

In contracted emplacements such as arise in mountainous regions, or generally on steep slopes, this arrangement may be advisable. In the line of the fort girdles, a high angle battery will probably be formed of two 6-inch howitzer turrets, about 65 or 100 feet apart, each with a mortar turret attached, thus combining 4 high-angle pieces under one fire direction.

The previously described gun and howitzer turrets have the advantage that they are so roomy as to offer space for mounting each a gun and a machine gun, as well as for posting a number of infantrymen, and for furnishing quarters.

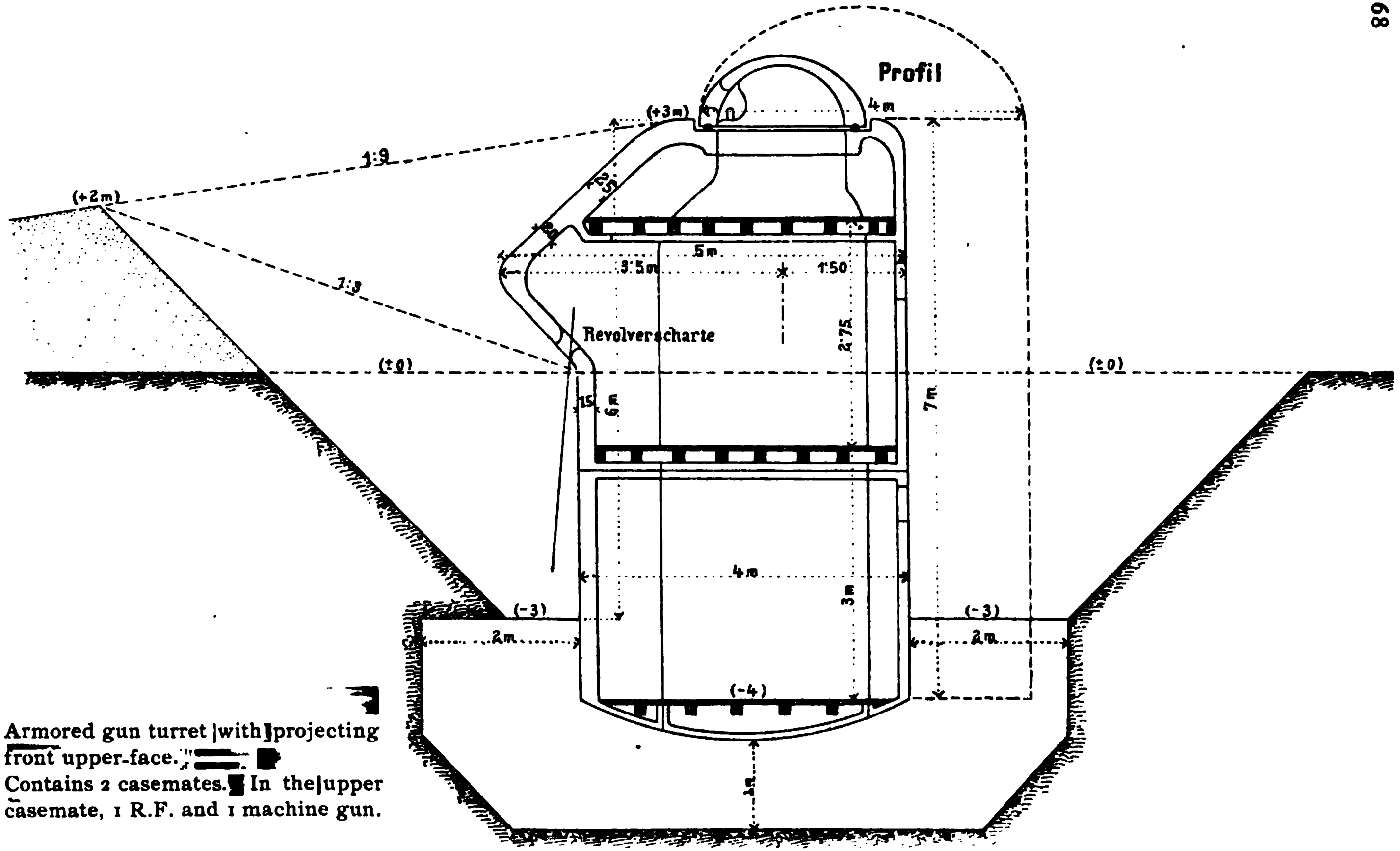
Thus about 20 men can be very comfortably quartered. In the two casemates 16 or 18 men may be posted on the flanks and the gorge (rear) who can fire with rifles on supports 18 × 40 = 720 shots per minute. But in order to economize men, it will be more advantageous to use machine guns or the simpler 37 mm. gun in place of infantry fire.

In case the same men remain only temporarily in the armored turrets, they and their reliefs can be quartered in concrete casemates which are placed in rear or to one side of the sphere of action of the turret guns, and in that case it would appear advisable, in order to diminish the weight and cost of the armored turrets, to reduce their diameter as much as possible.

In figs. 4*a* and 4*b* is represented an armored gun turret thus reduced, but principally in its base. The lower part of the tower stands back about 1 meter (3 feet 3 inches) further than the front of the inclined upper surface, since the former need not oppose to the shots an armor surface inclined at 45°, as the latter must. There is thus in the upper part a kind of armor moulding or cornice.

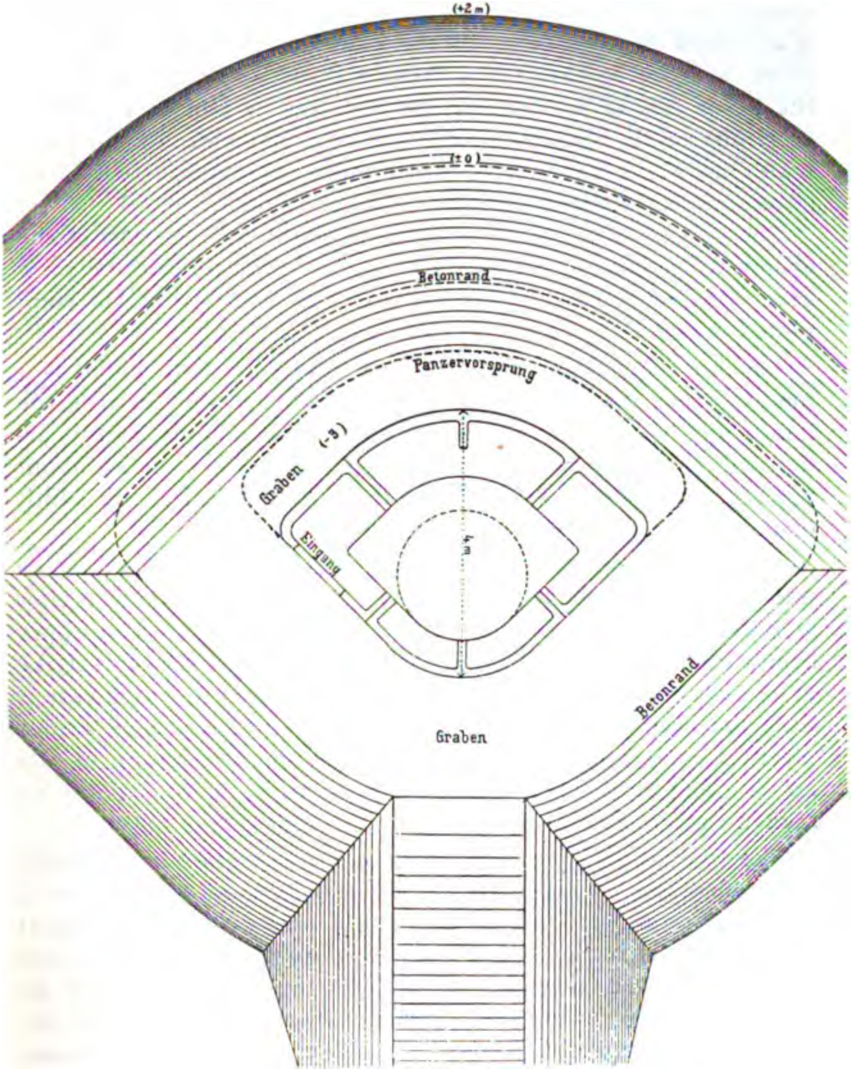
The upper part of this armor cornice is supported vertically by the strong lower side. The latter can only be hit very

Fig. 4a.



Armored gun turret with projecting front upper-face.
Contains 2 casemates. In the upper casemate, 1 R.F. and 1 machine gun.

Fig. 4*b*.



Plan of armored gun turret with projecting front upper-face.

obliquely, and the vertical wall of the lower tier can only be reached by very highly inclined curved shots which can hit only obliquely. The foundation of the tower is protected against high-explosive shell by means of an inverted armor cap and a massive block of concrete, as in the large turret. The entrance is at a flank in the ditch. In the 2 casemates of the lower tiers there is room in each for a rapid-fire and a machine gun. At the lower side of the cornice are revolver loop-holes for firing vertically on the space around the front armor wall. The 2 casemates have 2 × 12 = 24 square meters (258 square feet) floor space, and can therefore readily quarter 12 men.

The weight of the turret is 462,000 pounds, and the cost of the armor, at 30 florins per 100 kilograms, will therefore be 30 × 2100 = 63,000 florins, or $25,200, and the total cost of the completed tower set up in place, about $31,200.

The howitzer tower, built in a similar way, and which is 1 meter (3 feet 3 inches) lower and 1 meter narrower towards the flanks and the gorge, weighs about 363,000 pounds, and its armor will therefore cost about $20,000, its total cost being about $22,400. The mortar turrets, built up cylindrically, will admit of no further reduction of dimensions.

A further increase in the resisting power of the towers to shots may be effected by so profiling the front that the projectiles strike the armor plates at a smaller angle than 45°. The upper armor surface is inclined 1 : 2, so that a horizontal shot will strike at 27°, or one with an angle of fall of 5°, at 32°, in which case it does not seem possible to make a breach in the arched armor pieces, 8 or 10 inches thick, with ever so dense a group of hits on it. The long armor wall receives at its middle point an arched support resting on the vertical pillars of the tower.

The overhanging turret wall can only be attained by inclining the upper and stronger part at 45°, and farther down so as to give smaller angles of impact. Highly curved shots, on account of their small terminal velocity, have no appreciable effect on the armor. The overhanging wall is supported externally by means of sharply rounded buttresses, about 4 inches thick, between which concrete is packed. Sometimes the buttresses reach high up, in which case they are visible above. The enemy's guns placed to one side can, it is true, hit the side surfaces of the buttresses, but only with very curved trajectories, and never with sufficient inclination to produce any appreciable effect. This turret also receives an arched armor base or bottom to resist the action of high-explosive shell. The cost of such turrets is considerably greater than that of the ordinary turrets on account of their greater weight.

Since it is difficult to breach effectually large masses of concrete covered from view and lying deep down in a ditch, with curved fire of an angle of fall of over 1 : 2, and almost impossible to do this in case the concrete mass has a ribbed cast-iron armor plate, even though but 2 inches thick, well imbedded in the concrete, it is advisable, in order to reduce the cost, to replace the lowest of the armored casemates of the turret by a complete concrete foundation. The short vertical wall of armor permits of cutting revolver loop-holes in front, by means of which the ditch may be swept directly at this point in case the flank fire of the neighboring turrets should for any reason fail. The armor weighs about 396,000 pounds, and will cost about $21,600, and the entire turret with concrete base about $25,600.

Should a future increase in the effective action of artillery fire necessitate an increase of armor thickness of say about 60 per cent, or, for example, in the forward part of the tower from above downward, to 16 inches, 13 inches, 9 inches, 3 inches, the cost will increase to about $34,000, so that 100 such towers for an intrenched camp (about 60 for 10 forts, and 40 for the citadel*) would come to about $3,400,000. The cost of the howitzer towers will be less if in place of the lowest armored casemate they receive a mass of concrete. The concrete structures are built of large blocks, 35.3 to 95.3 cubic feet, fastened together by means of metal dowels, and the joints are pointed with gypsum mortar in order that they may be more easily separated when the tower is moved, and in order to be able to use them for other purposes in case the tower is abandoned altogether.

The resisting power of the tower may also be increased if the ground plan be made pointed towards the front, thereby also facilitating the glancing off of the shots in the horizontal plane.

The shots from the enemy's positions to one side of the tower will then attain more favorable angles of impact. But the enemy's battery cannot be placed far to one side, if it is to be placed near enough to the tower, and is not to be flanked by the adjacent fort. At 1640 yards a line of fire making an angle of 45° with the capital is not practicable, because the batteries will be so situated as to be taken in reverse by the other towers of the interval.

The towers thus far considered have cupolas of about 6½ feet diameter, and are therefore available for 3-inch guns, or 6-inch

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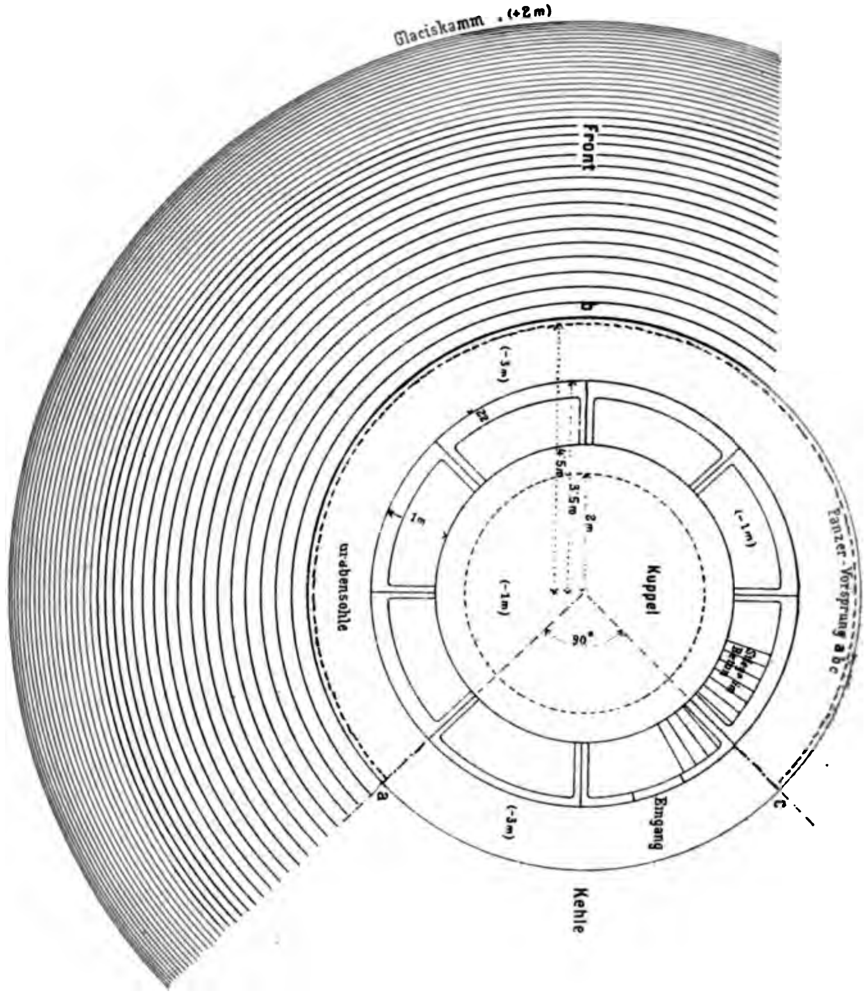
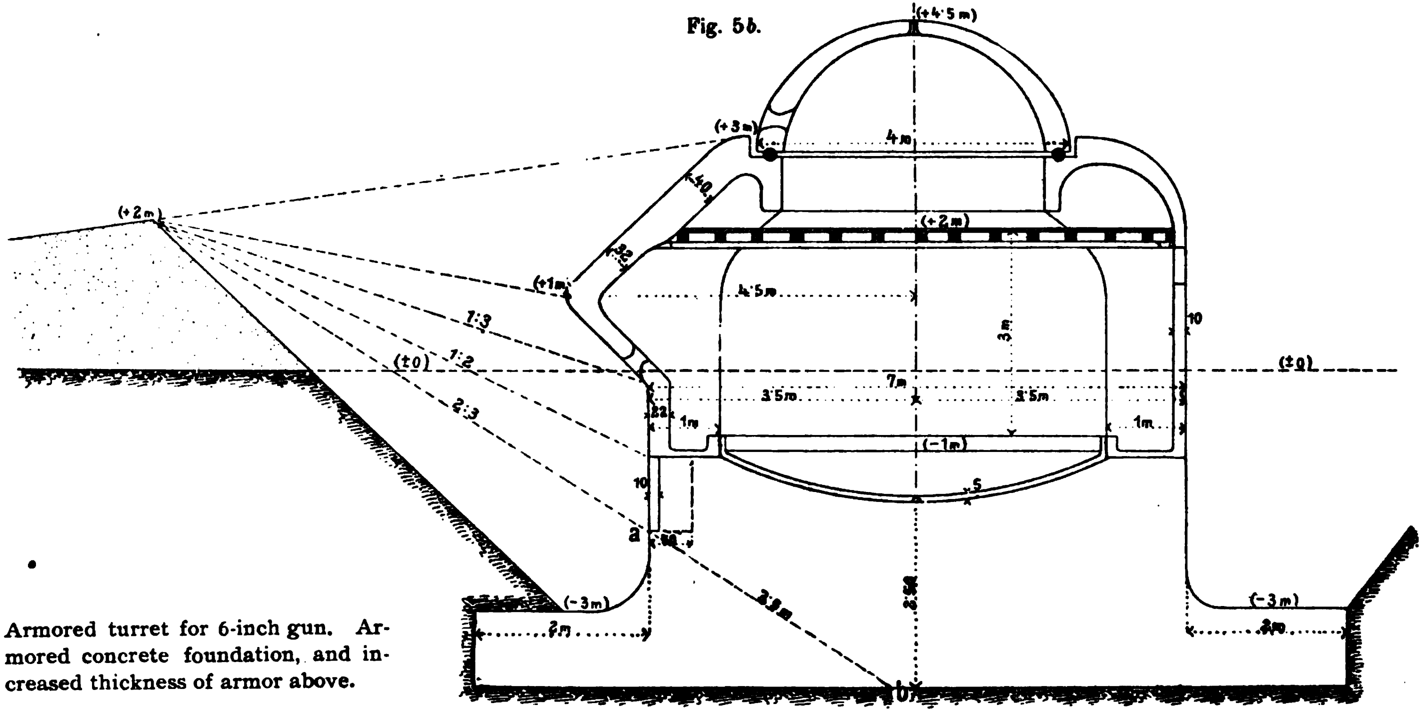
* Central or interior line of fortifications, usually immediately surrounding a fortified city.

Fig. 5*a*.



Plan of armored turret for 6-inch gun. Armored concrete foundation and increased thickness of armor above.

Fig. 5*b*.



Armored turret for 6-inch gun. Armored concrete foundation, and increased thickness of armor above.

howitzers. A similarly constructed tower for a 6-inch gun, with 13 feet diameter of cupola, by using the profile with projecting upper part, weighs about 770,000 pounds, and costs about $42,000 in armor alone, or about $44,800 in sum total, erected in position. A Gruson 15 cm. (6-inch) armored carriage without stone foundation was offered in its day for $36,000. The latter, however, had no gun casemate underneath.

The thickness of armor necessary to offer sufficient resistance, can only be determined by experiment. For this purpose a wooden model of the turret, or tower, is fired on, under conditions simulating war, with say 4,000 cast-iron projectiles (the ammunition allowance for 4 guns in a 20-day siege or bombardment), and the hits are plotted. From the hits on the various plates (breast-height plate, lower tower wall, cupola,) regarded as targets, the effect on armor plates with steel projectiles at 55 yards range is then calculated. The desired increase of thickness can usually be practically confined to the middle sector of 50° to 60°, since the necessarily close-range position of the batteries of attack prevents the latter from spreading over the entire sector of 90° around the tower flanks. The ends of the armor sector are also hit in an oblique direction only, considered in the horizontal plane.

Let us take an example, therefore, say that of a 6-inch gun tower, and determine what weights result in case such abnormal armor thicknesses are selected as to preclude all possibility of breaching, and then see if with such a quantity of armor it is still possible, in view of the great cost, to consider the application of this kind of structure.

In figs. 5*a* and 5*b* a strong armored tower of this kind for a 6-inch gun is represented. Below the cupola space it has but one armored casemate. It is built up on a mass of concrete rising 6½ feet above the bottom of the nearly 10 feet deep ditch. The mass is 23 feet in diameter and is buried over 3 feet in the earth. In order to cause high-explosive shell to explode in the earth as far as possible from the tower, the lower part of the mass of concrete is spread out for 6½ feet and is here a little over 3 feet thick.

The ground plan of the tower in this case is assumed as a full circle, which requires more material than the tower form with a 90° sector. On the front over a sector of 180° the concrete base is covered with armor about 4 inches thick, which has ribs about 20 inches broad, placed every 6½ feet, buried in the concrete behind it. The armor extends over the upper surface of the concrete which may be hit by curved shots with an angle of fall of 1 : 2 or 2 : 3. Shots of greater inclination with considerably diminished terminal velocity, giving an angle of impact of 55° or less, are no longer dangerous to the massive concrete block.

But even assuming that the attacker, in the front sector of 90° (farther to one side he cannot go, without coming too near the batteries of the interval which could act on his flank and rear,) succeeds in breaching the lowest layer of wall, and in such wise that he hollows out a place as wide as the angle of fall of the projectiles permits, namely, to 11.5 feet, there will still be left to support the tower the corner pillars of the angles of 45° adjacent to the 90° sector, so that its foundation remains intact for 270°, and is undermined only for 90°—hardly to the middle of the turret.

A greater breach towards the interior, however, the projectiles cannot make, because the concrete fragments do not fall out (the wall is only 3 feet 3 inches high,) therefore shot after shot will only convert the material into smaller fragments which still resist the projectiles. Against the explosive effect of projectiles penetrating so deep the tower is sufficiently protected by the masses of concrete and the inverted arch of armor nearly 2 inches thick.

The stairway in the concrete mass must be protected on the outer side by carrying the armor walls down from the casemate, in one of the armor plates about 4 feet, in the other (rear or gorge piece) about 6 feet 4 inches.

The armor thickness in the sector of 270° at the breastworks is 15.7 and 12.6 inches, which cannot be breached even by projectiles somewhat larger than 6-inch at 45° angle of fall. The overhanging wall of the armor cornice, which is only grazed at flat angles, receives a thickness of 5.9 inches, and the lower vertical tower wall, reached by angles of fall of ⅓ to ½, a thickness of 8.7 inches. For the gorge, which cannot be struck at all in the sector of 90°, the thickness of armor is the same as in the turrets previously described, namely, nearly 4 inches.

In the casemate, which is about 21.7 feet in diameter, there is room for mounting 1 casemate gun and 1 machine gun, besides for posting a number of infantrymen. The foot of the tower can be readily swept by revolver fire through well protected loopholes resembling machicoulis. At the points where the casemate gun and the machine gun are to be placed, the overhanging armor wall adjacent to the port hole is broken at right angles, and a vertical and horizontal part is there arranged.

The entire tower, or turret, weighs with its concrete armor about 836,000 pounds, and costs, therefore, about \$45,600, as compared with the above mentioned \$36,000 Gruson turret. The total cost will rise to \$49,600. A point of support with 14 armored turrets (6 gun turrets, 4 howitzer and 4 mortar turrets), the cost of which, as stated above will be about \$400,000, will cost about \$120,000 more, if it be strengthened by 2 such 6-inch gun turrets as just described; or, in other words, about \$520,000 will be required, which per gun (not counting flank-defense and gorge guns in casemates) amounts to $\frac{520,000}{16}$, or about \$32,500.

If we divide the cost so as to include 8 more flank-defense guns (besides the 16 already considered) which are undoubtedly necessary, the cost per gun will be $\frac{520,000}{24}$ = about \$22,000.

The turret for the 6-inch gun, of the kind described, however, possessed in its fixed part an excessive thickness, so that it may be assumed that the cupola will probably be dismounted long before the substructure will indicate any appreciable disturbance.

From these examples it is evident that it is quite possible to construct free standing armored turrets, secure against assault, of sufficient resisting power, and yet at reasonable cost.

As regards the grouping of the armored towers for a particular point of support, it may be added that the 6 gun turrets will probably be set up in 3 groups of 2 pieces each with about 440-660 yards distance between them. Behind the 2 intervals, 220-440 yards back, are placed the howitzer and mortars in 2 groups, of 2 howitzer towers and 2 mortar towers each, or in pairs.

The front of the point of support is, therefore, about 870-1300 yards long and has two lines of armored towers. The space between the two lines serves for the establishment of the open batteries of the defense or for strengthening the position by means of Schumann's portable armored towers.

The extension of the front of the point of support by means of a number of gun positions, as opposed to the method thus far used in a single work, facilitates greatly the effective command of the foreground, and consequently the defense, because dead spaces in the field of fire are not so apt to occur, and the attack cannot take place in such an enveloping manner as is possible with the single fort. For this reason, Baron Leithner, as early as 1899, in the third volume of his work entitled "Beständige Befestigung", very properly submitted more appropriate projects than heretofore in use, in which a subdivision of the gun positions into several short-range works and permanent batteries was proposed, and thereby raised a storm of undeserved criticism from a number of engineers who objected to the immense amount of wire required for the obstructions (wire entanglements) around his numerous works.

But such points of support, even without wire entanglements, furnish better defensive positions than the single large works with the very best wire entanglements, because the latter do not nearly so well meet the most important conditions (namely, of commanding the terrain on all sides and of reducing the effect of the enemy's fire,) as a group of works The broad front of the latter also reduces the extent of the interval (which is supposed to have but comparatively weak fire). Consequently, for these, special flanking guns may often be dispensed with, because the groups of the points of support are sufficiently close together to enable the cross-fire from their end points to command the interval (see groups 6 and 7 in the example given by Leithner). Only where the interval is too great(as in Leithner's example, between 1 and 2, and in 2 itself) are flanking guns necessary.

The unoccupied interval, due to the broad (about 1100 yards), and yet very strong, front of the isolated armored turrets shrinks from 3300 to 2200 yards. But over this space we have the action not only of most of the guns of the armored turrets of the entire point of support, (as far as the ground permits,) but also of those in the casemates of the latter. This gives for the two end points alone, with a 2200 yards interval, $2 \times (2 + 2) = 8$ guns, and with 3300 yards interval 8 guns in addition in the first line. In the second line the fire of at least the 2 outer groups of howitzer turrets (of two turrets in each group,) with, in all, 4 cupola howitzers, and $4 \times 2 = 8$ armored casemate guns, can be counted on. In this case rapid-fire howitzers are to be preferred.

The command of the intervals in the case of the proposed method of fortification with isolated turrets, unmasked on flanks and gorge, and arranged in tiers, is far more effective than in the forts thus far constructed, in which, in general, only 4 flank defense guns and 4 cupola guns come into play for this purpose, and these have, besides, a greater distance to cover. The flank-defense guns of the old forts, mounted in casemates, have, moreover, a limited sector of fire which does not allow them to be used against an attacker in position in the capital sector of the gorge, against which even the turret guns of most of the types of forts cannot fire. An exception is the case cited in Leithner's "Beständige Befestigung", Band III., Figs. 3 and 4, Plate I.

In case the attacker has once passed the intervals between forts and proceeds to advance against the gorges of the latter, this advance can take place more readily under the light gun fire of the older works. The infantry of the latter must, therefore, meet the attack. Recognizing these weak points in modern fort construction, Schumann (and his follower Meyer) organized his fortifications also in depth, that is, he arranged the system so that an enemy who had passed the first line would come at once within the radius of fire of the armored guns of the second line which was placed several hundred paces in rear of the first. Other systems bring the enciente, or inner line of works (noyau) to within about 2200 yards of the line of forts, in order to meet the enemy, who has broken through an interval, with the fire of the second line.

In the system of fortification proposed by me, the attacker also comes under the fire of the second line, in this case that from the howitzer turrets ; but, what is far worse for him, since the fire of the casemate guns combines with that of the cupola guns, he comes under a triple fire which takes him in flank and rear, if he attempts to advance farther ; or in front, if he attempts to attack the gorge of the first line, where he will have to take in succession 14 iron turrets, 10-20 feet high, secured against assault, meanwhile receiving fire in his rear from the second line. It can thus be readily determined how complete is the protection of the long-range batteries between the two lines of turrets.

If sufficient money is available, there will be no difficulty in placing also 4.7-inch and even 6-inch guns behind armor, preferably in rotating cupolas, surmounted on iron turrets, 6½-10 (not 20) feet high, hence, in spite of their large diameter, costing not much more than the above-described armored turrets for rapid-fire guns. The security of these heavy guns placed so low against assault is assured by the adjacent armored turrets which are secure against assault.

If in the turret represented in fig. 4, with a diameter of about 13 feet, the lower part, 10 feet high, is left off, and the diameter of the turret be increased to 20 feet, so that the cupola, instead of 6½, can be made 13 feet wide, the mounting of 4.7-inch and 6-inch guns is made possible. The lower cylindrical part, 3 feet high, is buried in concrete. This turret is also secure against explosive shell, and is very difficult to scale at the gorge and flanks and not very easily in front. It has a casemate for quartering a detachment, or for mounting a gun to fire towards the gorge or flank.

In the points of support proposed by me, and consisting of isolated armored turrets behind earth parapets, there is no special provision made for the posting of the infantry. The latter is supposed to act only from the casemates against flanks and gorge. But in order to economize men it will probably be better to replace it with revolving cannon (1.45-inch) or machine guns. In rapid fire, 4 maxim guns are considered equal to 2 companies as regards rapidity of fire, but equal to 1 battalion as regards accuracy, or number of hits (Fortschritte im Waffenwesen by Colonel W. Witte, Part II.)

Against an attack, the infantry will be most advantageously placed in the intervals between the armored turrets along the glacis of the latter, or in shelter trenches, which can be better adapted to the terrain than are usually the crests of the older forts. In this position the infantry can remain in action until the attack has broken through the line, and it must then retire to other lines farther in rear. The infantry fire will probably cease in that case; but its place will be taken by the numerous and far more effective casemate guns of the armored turrets, so that the flank and gorge fire of the 50-100 infantry rifles of the old forts can now be dispensed with, especially as there will also be some 14 maxim guns in action, which, according to the above comparison, are equal to 14 × 2 × 200 = 5,600 infantry rifles.

But if it be desired to keep infantry, under any circumstances, in the first position, even if the attack may have broken through the latter temporarily at a few points, separate infantry intrenchments may be interspersed in the intervals between the armored guns, the latter thus furnishing an effective flank fire for the infantry. The infantry intrenchments, like the isolated armored turrets, should be surrounded in the ditch with wire entanglements.

In the infantry intrenchments the Schumann portable armored turrets for 2-inch guns will be found most suitable.

If the infantry intrenchments, like the old forts, are to be made as secure against assault as possible, which cannot be effected by means of wire entanglements alone, and their permanent occupation by the enemy prevented, they must be strengthened by means of guns of position, flanking the ditches, with a clear field of fire over the ground in front, and commanding the interior of the work even after the assault, in order to render the enemy's occupation of the work impossible. These problems are best solved by means of the isolated armored turrets which are secure against assault. They can be so placed in the angles of a simple earthwork, in its ditches, or in prolongations of the latter, that they can take these points under fire with the cupola gun and the casemate guns, and with the former also reach out into the foreground, hence in the last moments of the attack take the enemy on the glacis and in the ditch with flank fire. They therefore, in contradistinction to the counterscarp or caponniere guns, fulfil the double purpose of serving both as long-range and as short-range guns in the defense.

If such turrets are also placed in the interior of the work, on the front crest line, over which they fire into the foreground, their guns will also command the interior of the work, which will thus possess, in the turrets, an inner redoubt, keep or citadel.

It is well known that keeps, or citadels, played a great part in forts up to the Seven Years' War. The most celebrated military engineer of the present time, Brialmont, makes use of them even today, although most of the engineers have given them up, because they must in general be built of masonry and therefore cannot be sufficiently protected against modern high-explosive shell. They are mainly secured by Brialmont through the armored cupolas on the top of the casemate-body.

Citadels of great resisting power constitute undoubtedly much to be desired reinforcements of works. Radetzky also proposed them, after the campaigns of 1848 and 1849, in a series of works in Verona: for example, 7 turrets in the works on the curtain of Verona at $100,000, and 1 turret for the Culoz work. It may also be added that even some isolated masonry turrets were proposed for certain points in Verona, for example, 6 turrets in the Chinsa veneta, and 4 turrets in the Position Spiazzi on the Monte Baldo (see Blasek, Beiträge zur Geschichte der Geniewaffe.)

[To be concluded.]

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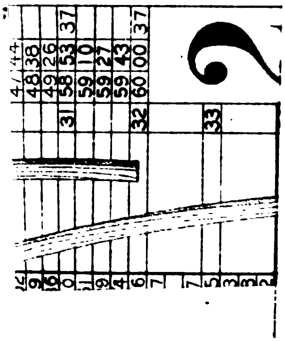

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PROFESSIONAL NOTES.

Combination Range-and-Drift Ruler for Mortars.

By Captain PERCY P. BISHOP, Artillery Corps.

A drawing, four-fifths size, of three zones of the range-and-drift ruler for mortars constructed under my directions and now in use by my company, accompanies this description. The features of the Best range ruler and drift ruler are incorporated in this ruler. The range-and-drift ruler is formed from one piece. It is used with a shifting center. The center of the pivot about which it swings represents the position finder or the directing point of the battery, as the case may be. In the case of a horizontal base line for range finding for the battery, one of the positions of the pivot represents the end of the base line nearest the battery.

The left edge of the ruler (left to one facing the field of fire from the position finder or the battery) is beveled and graduated in yards to the same scale as the plotting board—two hundred yards to the inch. The smallest subdivision on the scale represents ten yards. This we will call the first column of the ruler. The next column to the right (the second) gives elevations in degrees and minutes for the ranges directly on a line with them. It is to be observed that this column of degrees and minutes represents correct elevations for ranges opposite when correct powder charge is used.

The powder charges for the different zones are represented by large red and black numerals on the right hand side of the ruler. The powder for zone one is indicated by a large black figure "I," and all elevations to be used with this powder are indicated in black figures. Observe that from 3,000 to 3,500 yards the elevations for zone one and powder one are indicated in black figures in the second column. The elevations for zone number one shift, at 3,500 yards, to the column next the one on the extreme right of the ruler. They are still in black and still represent the correct elevations for ranges opposite over on the left hand side of the ruler when powder one is used.

In this way zone number one is allowed to overlap zone number two one hundred yards. It is seen that zone number two (figures in red) similarly overlaps zone number one one hundred yards, coming down as far as 3,400 yards. The total overlap is two hundred yards. This column, next the one on the extreme right of the ruler, has in it the angles of elevation for overlaps for all zones. In the column just to the left of it are times of flight to the nearest even second for every hundred yards. These times of flight are used only with the elevations on their left next the range scale. The column on the extreme right of the ruler contains times of flight for the angles of elevation on their immediate left—elevations for overlaps. The time of flight is in every case, of course, to be taken with the elevation for the range on the same line with it.

Near the center of the ruler, one opposite each large black and red zone and powder number, will be observed drift curves. There is one for each zone and powder charge. These curves are represented in the same colors as the elevations and powder charge for the zone with which they are to be used. They are constructed to represent accurately the linear drift, to the scale of the plotting board, at each point along the range scale. They represent the drift at each range, measured at the range edge of the ruler to the right hand edge of the drift curve. These curves are, in fact, slots in the ruler. The surface of the plotting board can be seen through the slots at all times. If it is desired to correct the azimuth of any point for drift, the ruler is swung over the point until the point coincides with the right hand side of the slot when its azimuth, corrected for drift, is read off the proper arc.

Ordinarily, then, the position of the target is plotted along the range edge of the ruler. The prediction is made, the set-forward point located, and then the range-and-drift ruler is swung to the left until the set-forward point coincides with the right hand side of the slot, when the corrected azimuth is read off the proper arc. The correction for drift is thus automatic. It requires practically no time to swing the drift slot over the point. The complete information for each zone is in colored ink, so that no confusion need arise in taking the proper elevation or using the proper curve in the overlaps.

The ruler in use by my company is made of wood. The upper end of the ruler has vernier scales on the range edge of the ruler for reading fractional parts of degrees on the arcs about the position finder and battery directing points.

This ruler, I think, should be made of metal—aluminum for example, with the drift slots cut through the metal. Each zone should have its distinct color for powder charge and elevations and the border of the drift curve should be colored to correspond. There is no opportunity for error then and any intelligent man can operate it with very little instruction beforehand. The range-and-drift ruler being in one piece it has the advantage of compactness and there is no attachment of any kind to be jarred out of adjustment or broken.

A New Device for Drift Correction and a New Set-Forward Ruler for the Mortar Plotting Board.

By Corporal O. VAN BEEK, Coast Artillery.

The Artillery Journal No. 56 (July-August 1902) contained an article by the late Major C. L. Best, Artillery Corps, on a plotting board for mortars. After a description of the plotting board and range ruler, a device mechanically correcting for drift is given and illustrated, called drift correction ruler. Its feature is the prongs, one for each powder zone, the ruler growing wider with increasing range, its width representing the linear drift for any corresponding point of the range scale.

This device was used in the plotting room of the mortar battery at Fort Monroe, Va., until September, 1903.

The increase in range and change in powder zones, as prescribed in General Order No. 111, of April 1903, and a certain change in the base line system of this fort necessitated the construction of an entirely new equipment of the plotting room.

But it had been evident before that two rulers on the board did not guarantee the celerity, security and accuracy, which are absolutely essential for this peculiar work. The drift ruler was continuously in the way and could never be quickly adjusted, small inaccuracies in setting the ruler resulted in comparatively great errors; often the ruler was applied to the wrong point, because the plotted point disappeared for a moment under the ruler. One was always in danger of applying the overlapping prong instead of the main curve or vice versa.

Different experiments were made with the intention of combining both rulers, but without satisfactory result. These experiments tended in the direction of keeping the drift ruler alone, graduating its straight edge and utilizing the hitherto unused surface as bearer of all the information found before on the range ruler. One of these schemes found the approval of the late Major C. L. Best; but it would not have removed the above mentioned faults of the drift ruler itself.

Therefore the writer constructed the simple device for drift correction, as illustrated by fig. 1.

It will be seen from the range table for mortars, as published by the Artillery Board, that the drift curves of the different zones have nearly the same limits, 2° 34′ being the smallest and 4° 40′ the maximum drift. This table gives elevation and drift, etc., for the full hundreds only. As we required them for each 25 yards we interpolated by formula:

$$A = \tfrac{1}{4}\,\delta_1 \qquad \Delta_1 = A + 3B$$

$$B = -\tfrac{1}{32}\,\delta_2 \qquad \Delta_2 = A + B$$

$$\Delta_3 = A - B$$

$$\Delta_4 = A - 3B$$

To lay off these varying drifts we constructed a quadrilateral (of metal) on the lower end of the right side of the range ruler, seen from the shifting center. (It seemed to be advantageous, regarding the channel, to place the graduated edge on the left of the new ruler.) The upper and shorter side of the quadrilateral (interior edge) represents the minimum drift of 2° 34′, as traveled by the vernier end of the range ruler; the lower and longer side represents the maximum of 4° 40′. To make the quadrilateral as small and stout as possible and to gain more space for graduation a wedge-shaped piece of the ruler was removed and the thus gained oblique edge beveled.

To get the desired correction we simply place a needle-point on the corresponding point of the beveled edge and move the ruler to the left until the needle touches the opposite side of the quadrilateral. The vernier on the left will read the corrected azimuth.

The length of the bevel was arbitrarily divided in 120 divisions and numbered accordingly. To insure correctness the drift correction for each number was found empirically; this experiment showed that each number corrected for the number of minutes of its numerical value + 2° 34′ — 1′; differences of ½ minute occurred but were not considered.

Thus each number corrected for a certain amount of drift, and as each occurring drift was represented, each drift had its drift number.

These numbers found their place on the ruler in the column before occupied by the figures expressing the drift in degrees and minutes. This continuous row of figures presented a welcome means of distinguishing the adjacent zones and their overlaps from each other, alternately using red ink for one zone and blue ink for the figures of the next.

While plotting and having the elevation found, the plotter gives the drift number, the operator of the azimuth vernier, not occupied at the time, lays off the drift and gives the corrected azimuth, The system was tried in numerous drills and tested in the recent target practice. It worked satisfactorily.

It is obvious that the quadrilateral may be placed on any side or any convenient part of the ruler, eventually to be manipulated by the plotter himself.

At first sight one is inclined to suppose that the side of the quadrilateral opposite to the beveled edge ought to be curved. This, however, is not the case, but the drift numbers of a zone plotted on the board will give the correct drift curve.

The device saves considerable time, excludes a source of error and simplifies the work of the plotter.

At the same time the writer devised a new set-forward ruler, which is a combination of a double speed scale (vessel moving to the right or left) and a set-forward chart in miniature. See fig. 2.

The speed scale is graduated on both ends to the scale of the board, 1 : 7200. As it is intended for two minute predictions the scale of the intermediate part is 1 : 3600 (100 yards of travel represented by one inch). The divisions of this part are numbered in both directions, to the right in black, to the left in red ink; the ink used on the two zero scales on the left and right of the two zero points is black and red respectively.

The miniature set-forward-chart is fastened on a shoulder and moves in a slot cut in the ruler (see section), its upper margin coinciding with the graduated edge of the ruler. The horizontal lines on the chart indicate the rate of speed to the scale of the map, the oblique lines divide them according to the times of flight. The vertical lines are only auxiliaries, guiding the eye or pencil. Two triangles, partially covering the same area, are on the chart, the left black-lined to be used when the vessel is moving to the right, the right and red-lined for a vessel moving in the opposite direction.

To use the ruler, supposing the vessel to be moving to the right: measure the speed for one minute, placing the ruler in the direction of the course, and holding it firmly in this position, set off this speed on the interior scale, the nearest edge of the moving tablet coinciding with the corresponding divisions. After getting the time of flight* for this point (predicted point) move with your pencil down the oblique line of the time of flight until it reaches the speed line (interpolating if necessary). The vertical line which crosses this point of intersection will guide you to your set-forward point.

A little practice in the use of this ruler insures great rapidity of work. As the speed of a vessel or towed target is nearly always uniform, the speed once set is good for a series of predictions, simultaneously checking the accuracy of the position finding. Numerous trials gave evidence that the ruler worked not only quickly but most accurately. Its chief advantange, however, is that the ruler once placed is not lifted from the board, thus invariably placing the set-forward point in the right direction. Furthermore, the man who previously operated the set-forward chart is available for other duties.

The ruler used in this fort is finished in brass and graduated by means of a dividing machine. The device is a set-back ruler as well; the line for 10′ time of flight has only to be added.

Using these two time savers it was possible to send predictions from the plotting room in 20 seconds, and with such correctness as the prevailing conditions of position finding, etc., allow.

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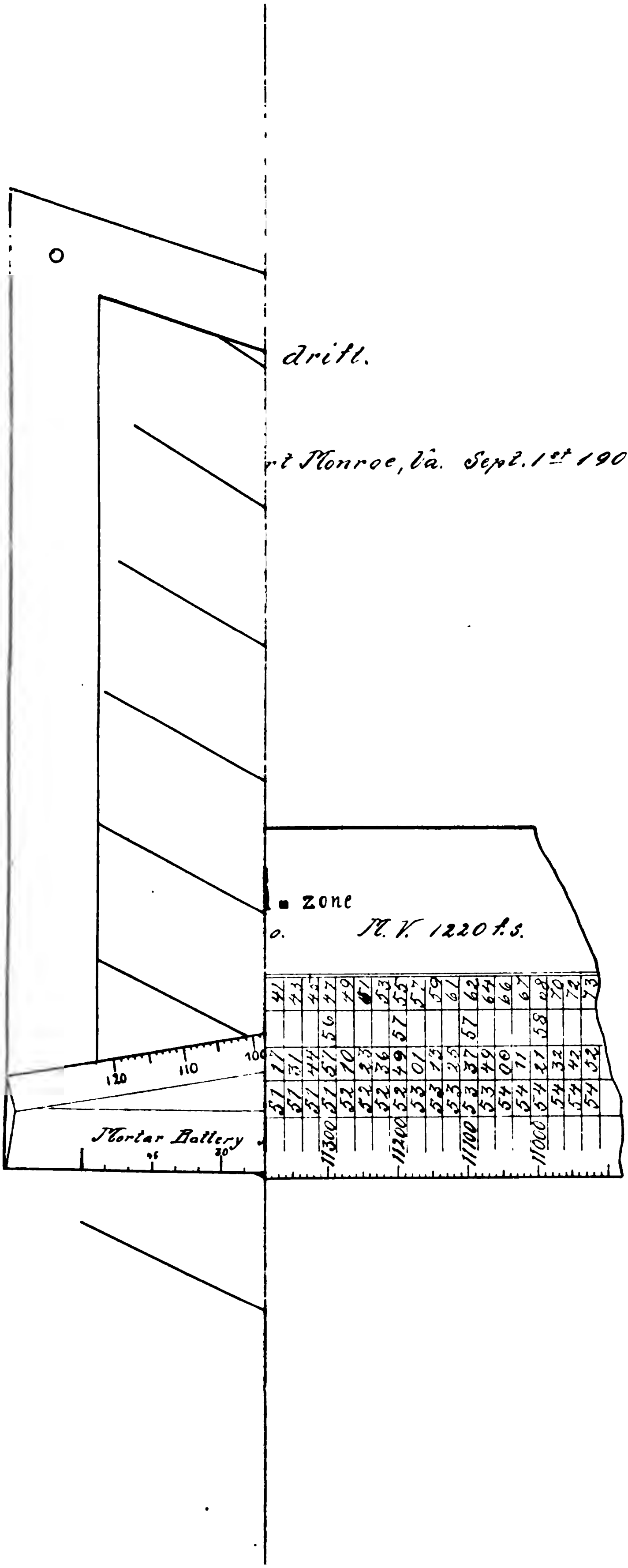
* It was found very convenient to place the limiting lines of the powder zones with their times of flight directly on the board.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rt Monroe, Va. Sept. 1st 1903.
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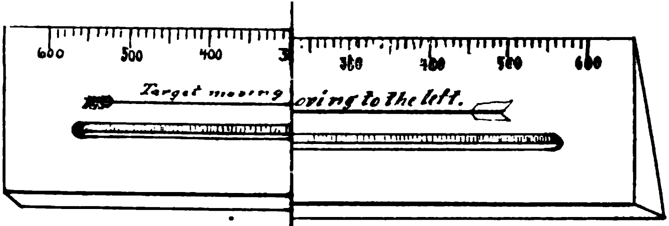

Single lines indicat

liding set-forward chart.

Van Beck, Del.

Monroe, Va., Sept. 8th 1903

With the new quick-inserting primer, having a slip instead of clamp screws to connect the wires and with a reliable elevating-indicating device (measuring the elevation from the stable part of the carriage or some form of a pendulum) it shall be possible further to reduce the time for mortar firing.

All this will tend to make this most useful weapon more efficient, which is very desirable as, under certain conditions, the mortars may be the only available and effective means of defense.

A New Departure In Explosives.

On November 13 Dr. Hans Goldschmidt of Essen, Germany, lectured in Columbia University on "Alumino-Thermics," or production of high temperatures by burning aluminum, and the application of this to metallurgy and engineering.

He showed how, by producing in a suitable manner the combination of oxygen and aluminum, a temperature is created about equal to that of the electric arc light, and how by the mixture of certain metallic oxides with powdered aluminum—thermite— and igniting it, the heat obtained by the reaction is used in producing a number of new metals and alloys, among which he mentioned chromium free of carbon, pure manganese, molybdenum, ferro-vanadium, ferro-boron, manganese-boron, lead-barium, et al., and how the heat is also used for welding iron and steel. As a remarkable instance of the latter use he described the welding "in situ" of the broken 9,000 ton stern post of the Hamburg-American liner Sevilla.

Astonishing as this is, the more so is the fact that powdered aluminum in certain mixtures constitutes a very violent explosive, probably more powerful than any known mixture. This is due to the fact that the combustion of aluminum at the moment of explosion increases the heat of the gases so much that they are expanded to a very high degree.

Explosives with aluminum as an ingredient are the invention of Herr Hans von Dahmen of Vienna, Austria, and have been patented by him in all countries. He uses nitrate of ammonia with certain percentages of powdered metallic aluminum, for some purposes adding charcoal, and he has given to these explosives the name of ammonal. They are manufactured in the prominent powder works of Mayr & Roth at Felixdorf, Austria, both for military and for mining purposes.

AMMONAL AS A BURSTING CHARGE IN PROJECTILES.

The problem of firing shells with high explosives for bursting charges from modern high-power guns has never been solved to perfect satisfaction. Guncotton, dynamite, nitrogelatine, melinite, lyddite and other explosives under a variety of names have failed so far. At least the degree of safety with which so charged projectiles can be fired from the guns is still uncertain, and occasional premature bursting inside the gun, destroying the gun and often killing the crew, is not wholly prevented. In most of these instances an explanation for the irregular action of the bursting charge cannot be found, but the facts remain, a serious warning against the use of the existing explosives for such purpose. In contrast to this behavior of the present explosives, ammonal cannot be exploded by shock; explosive shells filled with ammonal have been fired many times from guns with pressures up to 3,000 atmospheres, or nearly 45,000 pounds per square inch.

The present explosives, without exception, require for their regular explosion very strong fuzes or detonators; their power of action is even dependent on the strength of the fuzes, that is to say, the stronger the fuze the more powerful the explosion. And strong fuzes in themselves present an element of danger in transportation as well as in firing. Ammonal, on the contrary, is exploded by the ordinary fuzes, like bursting charges of black powder, which bring out its full strength.

The reason for this contrast between the present explosives and ammonal is that the former are chemical compounds, liable to combustion of different grade, producing different quantities of gases and of different heat and expansion according to the different grades of ignition. Ammonal, on the contrary, like ordinary powder, is a mechanical mixture, acts on a different principle, and when ignited, always develops the same quantity and tension of its explosion gas.

Armor piercing shell filled with ammonal will withstand the shock of hitting the armor and of breaking through it without exploding until the fuze acts. In case the shell breaks up in hitting or perforating armor, the ammonal bursting charge will not explode. On the other hand, when ignited by the fuze, the bursting charge of ammonal will explode with full power, notwithstanding any amount of compression it may have undergone by the force of impact. As with all compounds of ammonium nitrate, it is a serious question how sensitive ammonal is under the influence of moisture. The facts are the following: Pure ammonium nitrate is non-hygroscopic. Cartridges of ammonal prepared at Felixdorf, although exposed for a prolonged period to an atmosphere saturated with moisture, had not deteriorated in any way. Cartridges fired, with a quantity of moisture far in excess of what can be taken up by this explosive during careful manufacture, or after fair storage, gave entirely satisfactory results. An English authority on explosives says: "I have successfully detonated cartridges containing 10% of moisture by placing a dry cartridge containing the detonator on top, without any loss of power. I can therefore emphatically state that no difficulty is to be apprehended on this point." But, of course, ammonal prepared with ordinary nitrate of ammonium ought to be stored in hermetically sealed vessels the same as other powders and explosives.

Realizing these qualities of the new explosive, ammonal, the Austrian artillery has, after ample experiments, adopted it for bursting charges. The effect of a given quantity of ammonal is not dependent on the strength of the fuze, but it is dependent upon the percentage of powdered aluminum it contains. By this means its effect can be easily regulated and foretold; it can be varied within wide limits. The strongest mixture, containing about 20% of aluminum, is even more powerful than blasting gelatine, and it is this grade which is used in the Austrian artillery.

The present price of ammonal is sufficiently low to allow it to compete favorably with dynamite and other explosives. Besides it is more than probable that the price will be further reduced by an ever-growing market for it. The manufacture of ammonal, until now carried on only at Felixdorf, is still a secret. Aluminum is used in the form of an impalpable powder for military purposes, and as a slightly coarser powder for mining purposes. The disintegration of the metal to produce the fine powders is an especially invented process at Felixdorf, probably based on the experience that the aluminum metal at certain temperatures becomes brittle.

Ammonal, in order to produce the greatest explosive power, can be compressed to a specific gravity of 1.85, and coasequently confined in very narrow space. Such compression does not influence its easy ignition or the heat produced by its combustion. The new explosive, having great safety in manufacture, handling and transportation, with the highest efficiency, deserves the close attention of mining engineers as well as of the military authorities.

—*Army and Navy Journal*, December 19, 1903.

Ammonal Explosives, Ltd.

The above is the title of a new company, the prospectus of which was issued at the end of November. Its *raison d'être* is to manufacture a new explosive named "Ammonal," the special characteristic of which is that it is of the safety class of explosive, and that aluminum enters into its composition. Ammonal is of Austrian origin, the well-known firm of G. Roth having manufactured it themselves for some time past, and having succeeded in obtaining its adoption by the Austrian War Office for filling shells. Herr George Roth has accepted a place on the new English board of directors.

Mr. William Macnal reports upon the explosive as follows:—

"Ammonal is an entirely new departure in explosives, and presents several features of the greatest interest. It is essentially a mixture of aluminum and ammonium nitrate, with sometimes the addition of charcoal or similar bodies, and in this mixture advantage has been taken of the large amount of heat given out by the combustion of aluminum to enhance the explosive effect of the gases evolved by the explosive decomposition of ammonium nitrate. It is interesting to note that it is only within the last few years that the possibility of commercially using such an explosive as ammonal has become possible, owing to the great reduction in the price of aluminum which has taken place.

By invitation of Mr. G. Roth, of Vienna, I visited his works at Felixdorf and saw the whole process of manufacture of ammonal, and also a most exhaustive series of experiments demonstrating the safety and strength of this explosive and its suitability as a blasting explosive, and as a bursting charge for shells. I have also carried out a prolonged series of experiments and trials with ammonal made in Austria, and with samples made here, testing it for strength in the Trauzl lead blocks, and comparing it with other well known explosives. I have also seen it used in quarries in Austria and in Wales, and have seen it tried for bursting charges for shells at Messrs. Sir W. Armstrong, Whitworth & Co.'s range at Reedsdale.

As the question of the effect of moisture on the explosive was expecially raised, I have particularly experimented on this point, although considering the practical success which has attended the use of many explosives which are composed principally of ammonium nitrate, and which have to be protected from the action of moisture, no special difficulty was to be apprehended on that score. Of course, this explosive has to be packed in a similar manner to Roburite, Dahmenite, Bellite, Westfalite, and such like explosives. However, actual tests which I made with cartridges prepared at Felixdorf proved that, although exposed to an atmosphere saturated with moisture for a prolonged period, they have not deteriorated in any way. I have fired cartridges with a quantity of moisture far in excess of what can be taken up by this explosive during careful manufacture, or after fair storage, and the results have been entirely satisfactory. I have also successfully detonated cartridges containing 10 per cent. of moisture by placing a dry cartridge containing the detonator on top, without any loss of power. I can, therefore, emphatically state that no difficulty is to be apprehended on this point.

Important points to be considered in judging of the merits of an explosive, apart from the question of cost, are the degree of safety during manufacture, use and storage, and the strength and suitability for the work to be done. As is well known, the ammonium nitrate class of explosives is the safest to manufacture and use, and ammonal is not an exception to the rule. In fact, all the experiments which I have carried out prove to me that ammonal is the safest explosive at present known. It possesses, in a still higher degree, the insensitiveness to shock or friction, and reluctance to burn, which render the ammonium nitrate explosives so highly prized for their safety. It is not affected by frost, and thus the dangers are avoided which result from the careless thawing of nitro-glycerine explosives, which is the cause of many accidents. Ammonal is also extremely stable, for as is well known, aluminum is practically unacted on by nitric acid, and ammonium nitrate does not attack it. It has passed the tests of the Home Office, and is now on the "Permitted List," and will, therefore, be available for use in fiery mines.

Ammonal offers the great advantage that by varying the proportions of the components the strength of the explosive can be varied between wide limits, thus adapting it to the work it has to do. As to strength, the strongest mixture is rather more powerful than blasting gelatine, as tested in the Trauzl block, and gives a more shattering effect when fired open on small lead cylinders, "Crusher Test," the "Stauch Probe," of the Austrian Government. Trials which I saw made in quarries proved that ammonal is at least as strong as the best high explosives now in use. From the composition of the explosive it is obvious that the gases resulting from the explosion will be harmless, and experience proved that when ammonal was fired in close headings no noxious gases were produced. This, of course, is a most important point in regard to the health and comfort of the miners.

For blasting work ammonal is fired with a detonator. As a filling charge for shells for military purposes ammonal offers advantages possessed by no other explosive. I have seen shells filled with it fired through thick steel plates without causing the ammonal to explode. In some instances the shells were intact, in others they were broken by the impact, but the explosive was always found unexploded. Notwithstanding the great compression the ammonal had undergone through the impact, it still could be detonated easily. This fact that ammonal can be exploded when in a highly compressed state is of very great importance, for it enables charges for shells to be compressed into forms which closely fill the shells, and thus permits of a greater charge being put in than if the explosive were added in powder form; while for blasting purposes it can be compressed into cartridges of suitable size.

Comparative trials made with ammonal and picric acid showed that the former is by far the more powerful explosive. Ammonal used in shells can be exploded with only a percussion cap, such as is used for firing black powder charges, and does not require the strong detonators which are now used with some of the modern explosives, and which are always dangerous when used in guns.

In conclusion, ammonal is an explosive which is characterized by an extraordinary degree of safety, though its strength far surpasses that of any other explosive except blasting gelatine, which, however, it slightly exceeds. It is an ideal explosive for shells, being far more powerful than lyddite, melinite, or any of the picric acid mixtures, and at the same time safer than any of them. It will explode even after the greatest compression, thus differing entirely from the other known explosives composed principally of ammonium nitrate. For quarrying and mining purposes it offers the advantages of the greatest safety, and all degrees of power to suit the class of work to be done, and an entire absence of noxious fumes. Finally, it can be manufactured at a cost which I consider should enable it to compete successfully in this respect with any other high explosive, and, in my opinion, should have a brilliant future, both for military and industrial purposes."

Although the explosive is new to this country it has been well known in Austria for some time past, largely on account of the "flattering" attentions that have been bestowed upon it by persons hostile to its existence. As already stated, its chief characteristic is the employment of aluminum in its manufacture, the proportion of this ingredient varying according to the purpose for which it is intended.

—*Arms and Explosives*, December, 1903.

Cannon, Seacoast Guns, Ammunition, Etc., U. S. Service.

A number of rapid-fire guns of 6-inch caliber have been mounted during the year. These guns have a velocity of 2,600 feet per second. There are now nearing completion forty-six 6-inch rapid-fire guns of .50-caliber length of bore, designed to give a muzzle velocity of 3,000 feet per second. Several of these guns have been completed and issued to various establishments for testing carriages under construction. All will be emplaced in the near future.

A firing mechanism has been developed within the year; it permits the insertion of the primer after the manner of a small-arm cartridge while the breech is open. The primer may be fired either electrically or by friction, and has the necessary safety features to prevent firing until the breech is closed and locked. Mechanisms of this design are now under manufacture for every seacoast gun and mortar in service; they are fairly satisfactory and constitute an advance over what they replace, but there is room for the improvement which is being sought.

One high-powered 12-inch B. L. rifle, model of 1900, has been mounted in New York Harbor and tested. This gun, firing a projectile weighing 1,048 pounds with a velocity of 2,550 feet per second, has a calculated muzzle penetration of 37 inches of face-hardened armor. Two more guns of this type are completed and eight are nearing completion. The development in high-powered guns of large caliber in recent years may be shown by comparing the muzzle energies of the 12-inch B. L. rifle, model of 1888, using brown powder, and the same for the 12-inch B. L. rifle, model of 1900. The model 1888 gun gave 28,000 foot-tons of energy at the muzzle, while the model 1900 gives 45,000 foot-tons, an increase of about 60 per cent.

High Explosives.—A considerable supply of high explosives for filling shells has been secured and is being loaded into projectiles as rapidly as the present plant will admit. The installation of a loading plant for this material has been attended with some difficulty. Special machinery had to be designed and built and buildings planned to afford protection to the operators and facility for handling the heavy projectiles in quantity.

During the year a new 12-inch mortar has been destroyed by the premature bursting in the bore of a torpedo shell charged with high explosive; the cause of the accident is believed to have been the weakness of the projectile, which was of cast steel. The use of these projectiles in the service has been discontinued as a consequence of the accident, and if further investigation shall confirm the idea now held the supply of them on hand will be expended in target practice without explosive charge. In the meantime a stronger torpedo shell will be designed, to be made of forged steel, and possibly sacrificing some of its interior capacity to the necessity for greater strength.

The ordnance department has recently installed a refrigerating and heating plant at the proving ground for the purpose of investigating the effect of heat and cold on powders, and of determining if possible the laws of variation in pressures and velocities for changes in temperature. Tests thus far made indicate that temperature has marked effect on smokeless powders. Laboratory and proof tests during the year have led to the general revision of the specifications, the most important of which are, first, change in the heat test, which now requires the exposure of a sample for forty-eight hours to a temperature of 115° F. Under such conditions the loss in weight must not exceed 8 per cent. Second, the introduction of a compression test to determine the toughness of the colloid.

Retests of lots of smokelsss powder that had been in store more than a year have been systematically made. From these it appears that the ballistics of most lots will change during storage, and that in general the pressure and velocities will increase. It is also noted that many lots (notably those showing lack of toughness) give very irregular results when fired under high pressure (i. e., pressures between 38,000 to 40,000 pounds per square inch). In such cases there appears to be a critical point in the pressure which when reached with a normal charge fluctuates, together with the velocity, for the same charge. To meet this the department has recommended the reduction of the service velocities about 50 feet per second, the pressure corresponding to this reduction being sufficiently far from the "critical pressure" to insure uniform ballistic results and corresponding increase in accuracy of firing.

Of the elements which go to make up the power of a gun the powder must now be considered, notwithstanding comparatively recent very great advances, as being in the most backward stage. It is quite possible to construct cannon of sufficient strength to resist a pressure as high as 45,000 pounds to the square inch, and projectiles can be produced of sufficient toughness and hardness to utilize the velocity resulting from such pressures when fired against armor plate; but when it is attempted to use the powder at a pressure higher than about 38,000 pounds per square inch it is found that no certainty can be had that it will not mount to a very much higher figure, one much beyond the assured strength of the gun. Investigations for determining the exact reasons for this behavior, it is hoped, may lead to their removal.

Armor piercing projectiles, charged with high explosives, will be issued as rapidly as the loading plant can turn them out. The total reserve on hand is only about half of what should be in the forts, and if all issued would leave none in the main depots for a general reserve.

SEACOAST CARRIAGES.

Much attention has been given to the installation on seacoast gun carriages of safety switches for permitting the firing by electricity of the guns mounted thereon, also to the illumination of all azimuth and elevation scales for night service. As the matter of percussion or electric firing of guns is still under consideration, no definite conclusion in regard to the proper method of wiring carriages, nor as to the safety arrangements, has been reached.

The manufacture of 6-inch barbette carriages has been delayed somewhat by the failure of American spring makers to furnish satisfactory counter-recoil springs, and to a certain extent the delivery of the carriages has been interfered with by the unsuccessful efforts of the department to procure shields for them at satisfactory prices. The lack of success in procuring these shields. it is thought, resulted in a measure from the fact that because little experience in ballistic resistance of shields mounted on gun carriages had been had in this country, and, so far as known, little exists abroad, there was a natural hesitancy on the part of the manufacturers to accept the specifications of the department in regard thereto. It is to be noted, however, that there are but two manufacturers in this country capable of supplying them, and that owing to a press of other work there was a disinclination to take up the manufacture of these shields in limited quantities.

In order to obtain information in regard to their manufacture and ballistic qualities a contract was made with the Bethlehem Steel Company for five harveyized shields in accordance with plans and specifications of the department, and one shield was delivered for trial at the Sandy Hook proving ground. This shield was 4½ inches thick, the extreme dimensions of the developed plate being 132 by 78 inches. The plate is bent to a cylindrical surface with a 44-inch radius and attached to the gun mount by spring supports on each side with the face inclined at an angle of 40 degrees to the horizontal. The shield, with its bolts and spring supports, weighs 10,800 pounds.

Fire was directed so as to subject all parts of the shield about equally to the forces arising from the impact of the projectiles, and the test included a variety of striking angles. At the conclusion of the firing, the mount could be easily traversed, the pivot having received no injury. The shield remained in position, affording practically the same protection as originally, but was considerably damaged by cracks in the axial plane, which nearly divided the shield into two parts.

The test indicates that this shield is practically proof against penetration by projectiles of less caliber than 6 inches, since a 5-inch capped shot penetrated only 1.75 inches when fired at a simulated range of 2,140 yards for 3,000 feet per second muzzle velocity and a 48-degree angle of impact. Other 5-inch projectiles fired at a simulated range of about 3,300 yards, with a 60-degree angle of impact, produced no greater effect. With 6-inch projectiles the plate is over-matched, and may be perforated with angles of impact likely to occur in battle at ranges within about 3,000 yards.

These shields can be considered as efficacious and desirable for protection only against fire which is not able to perforate them. Where perforation is secured, and against the fire of heavier projectiles than 6-inch caliber, the shield, which cannot be made thicker than 4½ inches in view of weight and cost, becomes an element of danger.

Advantage has been taken of the test of the 12-inch disappearing carriage, L.F., model of 1901, to verify the accuracy of the formulæ heretofore used in the calculation of the throttling openings of the hydraulic recoil system of gun carriages. These experiments, while not completed, indicate that the pressures in recoil cylinders have been higher than those calculated, and indicate the necessary correction to be applied to decrease this increased resistance, which is thought to be principally due to the contraction of the liquid vein in the flow of the oil through the orifices.

Investigations have also been made with a view of ascertaining the suitability of a mixture of water and glycerin for use in recoil cylinders of gun carriages to replace the neutral oil used by this department. A mixture of glycerin and water is used abroad and in the naval service of this country. It is understood it was originally chosen because of its low freezing point, noncorrosive properties, and cleanliness. Water has been added to govern the viscosity, and also because the affinity of glycerine for water caused the leather packing, formerly used, to become dry and ineffective. This mixture, not being greasy, is preferable to oil on shipboard, as it does not stain the decks. A mixture of 80 per cent glycerin and 20 per cent water is generally adopted for use in naval mounts.

One reason for making this investigation was to determine, if possible, a mixture which would be less likely to rust parts of the hydraulic system than the oil now used in our service. It is to be understood that in refining oil, acids are used which must afterwards be entirely neutralized, otherwise rusting of parts will result. Under more recent specifications the department has succeeded in procuring oil which is almost entirely free from these acids.

This investigation indicated that mixtures containing 50 per cent of glycerin or less are excessive rust producers. Mixtures of 80, 75, and 66 per cent produce rust slightly, and while rusting increases with the decrease of glycerin in the mixture, it is not much greater with the 66 per cent than with the 80 per cent mixture.

The tests indicated that neutral oil was superior to the glycerin mixture in every point except the cold test, but the latter, it is thought, will not prove a serious objection in service, as the oil ceases to flow only at zero Fahrenheit. Its noncorrosive qualities are equal to those of pure glycerin; its viscosity is more uniform than that of any glycerin mixture that may be used, and its cost is only about one-fourth of that of the glycerin mixture.

TELESCOPIC SIGHTS.

The telescopic sights heretofore used in our seacoast service have not been entirely satisfactory, due to a lack of proper illumination of the focal image. This lack of light is naturally seriously felt in the hazy or foggy weather which is so likely to occur on the seacoast.

In order to improve this feature of the telescopes there appeared to be no other remedy than to increase the diameter of the object glass to about 3 inches and, as this increased the weight of the telescope, to use stronger attachments and fastenings to insure its rigid attachment to the gun carriage.

The department now has under manufacture several of these telescopic sights with increased diameter of objective which have excellent light-giving qualities and, it is hoped, will meet with favor in the service. In increasing the objective it was desirable to increase the magnifying power also, but at a sacrifice of field. In view of the open sights provided with these telescopic sights, it is thought the small field will not be objectionable in consideration of their other excellent qualities.

These sights will have a 3-inch triple objective, 15-inch focal length, Brashear-Hastings erecting prisms, and two eye-pieces giving powers of 12 and 20 with a field of 4 degrees and 3 degrees, respectively. The eye end of the telescope will be provided with a rack and pinion for focusing, and with adjustable cross wires. Means have been provided for illuminating the scales at night; also for the illumination of the image, should this be found necessary. The deflection scale is placed where it can be conveniently read, and is graduated to 0.05 degree, and to cover an arc of 2 degrees to the right and 2½ degrees to the left. All graduations are made on strips of German silver, and a range drum is attached which will be graduated for each particular gun at such time as the range scale for the gun is determined.

GAS-CHECK PADS.

Experimental pads have been manufactured and tested in which it is sought to obviate the difficulty experienced in service during fire due to the melting and softening of the pad material under the influence of heat. In one type the exposed edge (periphery) of the pad is protected by a copper covering; in another, the thickness of the pad is reduced so as to present a much smaller exposed surface. The latter type necessitates changes in the filling in disk and rear split ring. Both types have given good results in firing tests at the Sandy Hook proving ground.

Experiments have also been made with oleo stearin as a substitute for tallow in the pad composition. The results were so favorable, as regards absorption of moisture, that a number of pads having oleo stearin substituted for tallow and waterproofed with oleo stearin, and also some pads with the usual pad composition waterproofed with oleo stearin, have been manufactured and sent to the Sandy Hook proving ground for test.

—*Report of Chief of Ordnance*, 1903.

The New Swiss Artillery. The Shield Question For Field Guns.

The latest field artillery material is that recently adopted by the Swiss army. It is therefore interesting to observe, with regard to the much discussed question of gun shields, the impressions received by the Commission that has carried out the preliminary trials of the new material. The following is an abstract of the report of that committee.

"The Krupp experiments show that, thanks to the possible further improvements of the system of piece recoiling on the carriage, it may be practicable to reduce by 110 pounds the weight of the carriage and piece without impairing the strength of the gun and its stability while firing. This reduction in weight will permit of increasing the thickness of the shield up to .18 inches without exceeding the total weight of 2200 pounds for the piece in battery.

Two of the members of the committee pronounced against the introduction of gun shields, but the majority of the members were in favor of such introduction. However, the question of dimension for the shield has been deferred until some time before the completion of the new material; but it is announced that the size will be reduced as much as possible and that the side wings of the shield are to be dispensed with.

As regards the armoring of the caisson, this evidently can only be done at the expense of the ammunition-carrying capacity. If the caisson is to be placed in position alongside the gun, it must be armored; otherwise a lighter type may be adopted able to carry a larger quantity of ammunition.

The placing of the caisson alongside the gun offers the advantages of facilitating the handling of the ammunition and of protecting part of the personnel from shrapnel and rifle fire. On the other hand, this method exposes the entire personnel and the gun itself to the risk of an explosion caused by a shell penetrating and bursting inside the caisson. Furthermore, the large aggregate surface of the shield, piece and caisson offers the enemy a very large target.

The solution of the question is one of tactics. In Switzerland the nature of the ground often insures a good ammunition supply service without the necessity of placing the caisson alongside the gun. When, however, it becomes necessary to do this, it should be the caisson body and not the limber which would be placed alongside the gun, as it is more important to save from injury the limber than the body. The tendency will thus be to armor the caisson body rather than its limber, and that only as far as is absolutely necessary.

In any case, the weight behind the team whether for piece or caisson, must not exceed 3,960 pounds. Any excess over this weight would materially impair the easy maneuvering of the Swiss artillery over the ground on which it would probably have to operate in case of war."

It appears from the above that while the question of the adoption of gun shields has been resolved in the affirmative in Switzerland, no solution has been come to as regards the extent of the armoring. The object kept in view seems to be to keep the artillery carriage as light as possible so as to insure its mobility.

—*By courtesy of Chief of Second* (*Mil. Inf.*) *Division*, *General Staff*, *U.S.A.*

Russian Rapid-Fire Field Gun, Model 1900.

The Poutilov works (S.E. of St. Petersburg), as a result of trials held during 1898-1900, have constructed new rapid-fire material, according to General Engelhart's design, for the Russian field artillery. The gun is of 3-inch caliber (76.2 mm.) and replaces the light 86.9 mm. field gun and the heavy 106.7 mm. gun. The use of the latter was practically given up in 1900.

A recent book by Lieutenant-general Pototskii, professor at the Michel Artillery School and member of the Russian Artillery Committee, gives some new information in regard to this modern material.

The gun weighs 865 lbs. (393 kg.) It is provided with a single-motion screw fermeture, which is similar to the Schneider-Canet design, and fixed ammunition is used. The shrapnel weighs 14.5 lbs. (6.56 kg.) It has a base powder chamber and contains 260 bullets of 10.66 grms. weight. The weight of the bullets is 43 per cent of the weight of the projectile. The muzzle velocity is 1930 f.s. (588 m.), with a maximum pressure of 2,250 atmospheres. The muzzle energy is 375 foot-tons, or nearly one-half more than that of the German gun, model 96, and a little greater than that of the French gun, model 97. The remaining velocity at 2 versts (2,335 yards) is 1118 f.s. (341m.) The maximum range of the shrapnel is about 5,795 yards (5,300 m.).

A combination fuze of aluminum is provided, weighing 273 grms.* It is ovoid in shape, similar to the Italian fuze 75A. The time of burning can be as much as 22 seconds. There are two rings containing fuze composition; the upper one **A** is immovable, the lower **B** is easily moved by hand and is held in position in firing by an obturating ring. The setting is done by hand without any key or other tool, and consists in bringing the indicated division opposite the index r. When the gun is fired, the fuze composition ignites in a and burns until it reaches r. Combustion is then communicated to that in the lower ring and is transmitted in an opposite direction in this ring until it reaches the origin of graduations; the useful amount burnt is thus equal in the two rings.

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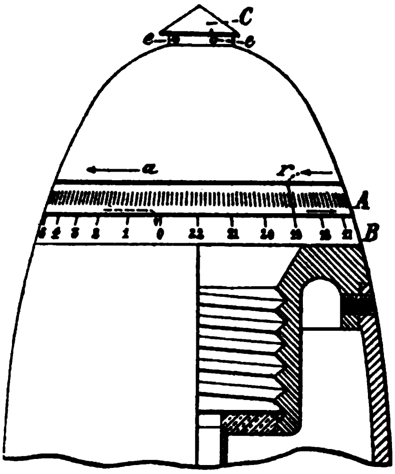
* Complete information as to the details of this fuze are not at hand. It is known that it secured for its designer, Captain Komarov, the award of the Michel 1st Grand Prize for the period 1896-1901.



The gases escape by the vents e let in under the screw cap C.* This arrangement has been recognized as necessary in order that the fuze may not become extinguished in flight. This is what happened, in fact, with older forms of fuzes in which the escape of gases was effected through vent holes on the circumference of one of the rings. The Russians had already been led to give up this form in the fuzes designed for the projectiles of the 57mm. rapid-fire gun.

The carriage, constructed according to the ideas of General Engelhart, consists of a main carriage, capable of motion in azimuth on the axle, and an upper carriage or cradle which is supported on guides fixed on the main or lower carriage, and recoils about 36 inches (91 cm.). These guides have an inclination corresponding to that given to the piece at average battle ranges.

The main or lower carriage is provided with a rigid trail spade, and the recoil of the top carriage, which recoils with the gun, is checked by means of an hydraulic brake and a column of rubber buffers separated by steel washers, the whole being assembled on a long spindle.

The rubber absorbs the greatest amount of the energy of recoil to restore it again by returning the piece into battery, and experience has shown that the gun may be fired with the brake empty or containing a very small amount of liquid.

When the gun is fired, the carriage jumps a little, but this does not prevent the rapidity of fire from attaining 15 to 20 shots per minute.

The mechanism for giving the elevation is attached to the top carriage. Aiming is done by means of a sight and foresight fixed on the gun. The laying apparatus for direction is similar to that of the French gun. On the axle are placed two seats for cannoneers in traveling.

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* In assembling the fuze, this nut C is locked in such a manner as to allow the ring B to be readily turned by hand.

The weight of the gun and limber fully equipped is 4,153.5 pounds (1884 kg.). For the caissons, it has been found necessary to give up the system of attachment—hinged-pin—used in the caissons model 1889,* and to make use of a pintle in order to be able to separate the caissons from their limbers more rapidly. The new drill regulations prescribe, in fact, placing the caisson bodies beside the pieces during action, just as is done with the French material, model 1897,

—*Revue d'Artillerie*, October, 1903.

War Material—1903.

During the past year, the gun, in its unending duel with the armor plate, has unmistakably scored. While the progress in resisting powers of the former has been for some time at a standstill—a 6-inch K. C. plate, for instance, is little, if any, better now than it was three years ago—the attacking power of the gun has been very greatly increased. This is due as much, if not more, to improvement in projectiles and propellants as to progress in gun construction. As far as projectiles are concerned, the cap has now been officially adopted as far as armor-piercing shot are concerned, and its adoption in the case of armor-piercing shell is only retarded by the fact that existing designs of shell are hardly strong enough to derive benefit from it. Now, however, that this is generally recognised, it cannot be long before armor-piercing shell as well as shot will be capped, and once this is a *fait accompli*, it is to be hoped that only two classes of projectile will be retained in the service, armor-piercing shell and high-explosive—lyddite—shell. Up to now the cap has only shown increased penetration at velocities of 1800 foot-seconds and over, but it is quite on the cards that with further improvements in projectiles, it will be effective at very much lower, if not at all velocities.

The 9.2-inch gun now threatens very seriously at fighting ranges all thicknesses of plate from 9-inch downwards. The latest mark of this gun can put A. P. shell through 6-inch of K. C. up to 30 degrees inclination at 4800 yards. Striking directly, the 12-inch, Mark IX., could get through any waterline armor afloat at 5000 yards, and at 30 degrees it is capable of dealing with 10.5 K. C. at 3000 yards

In view of this, belt armor for battleships must inevitably be thickened. As, however, we must have very nearly reached the limit in displacement, this can only be effected by a reduction in speed or by reducing the armored area. The latter course is that which will be most probably adopted. A very excellent model for imitation in this direction is provided in the new French battleships of the Patrie class, which embody the following main features:—Combined belt and deck armor, 15-inch to 11-inch of K.C., or equivalent steel; heavy gun bases, 12-inch; side armor above belt 8 inches, and 6 inches over the secondary gun positions. The belt is 12½ feet in depth, which appears ample for all practical purposes. Their armament, however, is inferior to that of our latest designed battleships. The addition of the 9.2-inch gun to the secondary armament of these latter ships is a great step in advance, and enhances their value enormously.

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* In these, extensive use was made of rubber cushions or buffers on the form of pintles, etc., used, in order to diminish shocks to the material on the road. They diminished the effects of vibrations, etc., but the carriages could not be separated quickly.—Tr.

The 6-inch gun is useless as an armor piercer against anything over 4-inch of K. C. or similar quality armor, for although it can get capped shot through 6-inch K. C. when striking normally with a velocity of 1900 foot-seconds, this only corresponds to a range of 1700 yards, and the minimum fighting range will be somewhere about 3000 yards; moreover, the average striking angle on service will be somewhere about 30 degrees, and at this inclination the cap is of no service. It is to be hoped that the 7.5-inch gun will be mounted instead of the 6-inch gun in the new ships now about to be laid down, and also in those which will be laid down in the next financial year. In the armored cruiser class the new Duke of Edinburgh and her sisters mark a notable advance, 6-inch of K. C. on belt and gun positions, combined with six 9.2-inch and ten 6-inch guns, together with a speed of 22½ knots make up a very formidable combination of fighting qualities.

Heavy gun sights still seem to be insufficiently protected, and it is to be hoped that this very serious defect will be remedied in future designs, when we bear in mind the paramount importance and value of the primary armament. It is satisfactory to note the steady progress which has been made during the past year in naval gunnery. The normal rate of fire from the 6-inch guns is now five rounds per minute, and nearly one round per minute can be got off from the 12-inch. There has also been a considerable improvement in the rate of hitting with the 6-inch gun. The ranges for prize firing are absurdly short, however, and we hope to see them doubled in the near future.

Turning to the question of propellants. Cordite M. D. is now out of the experimental stage, and with the diminished erosion which it secures we may confidently look for higher muzzle velocities than have been attained hitherto. Surprise has frequently been expressed at the high muzzle velocities which our American cousins and some private firms in this country claim for their guns. It must be borne in mind, however, that to attain these high velocities either a very large charge of cordite must be employed, involving speedy erosion of the bore, or else a powder must be used which has a very much lower temperature of burning than cordite, This can undoubtedly be had with several nitro-cellulose powders, but such powders are, compared with cordite, very unstable, and not suitable for the very varied conditions which obtain in the British service. Cordite M. D. is a happy compromise. The percentage of nitro-glycerine in the powder has been substantially reduced from 58 per cent. to 30 per cent., and the temperatnre of burning is therefore lower, while the keeping qualities of the powder are equal to those of the original propellant.

To turn to questions which affect the land service only, we seem to be at least in a fair way to obtain a really good field gun in the proposed 18-pounder. It has given the greatest satisfaction in the experimental trials during the past year, and it is to be hoped that it will before long be issued to the Field Artillery. The long-recoil system—as in the French and Ehrhardt guns—which is essential to a real quick-firing field gun has been approved, and a shield is also to be fitted. It is understood that the double-laying system has also been adopted, but details as to the proposed sights are not yet obtainable. All the above developments are in accordance wfth the most advanced continental ideas on the subject, and the gun will be a vast improvement on the 15-pounder, which, however, in spite of its many South African critics, did us very good service during the late war. Less progress seems to have been made with the new Horse Artillery guns, which is to be a 12-pounder or thereabouts.

It has been found difficult to keep the carriage absolutely steady during recoil, and unless this can be done no gun can be worthy of the name of quick-firer, a quick-firing gun being essentially a quick-laying gun. The interrupted screw breech mechanism is to give place to the wedge, or sliding block and fixed ammunition will be used. The past year has also seen the adoption of a new rifle, which is to replace both the existing rifle and carbine. It is a compromise between the two as to length, the new barrel being about 25-inch, as against 30-inch in the Lee-Enfield rifle and 21-inch in the carbine. The following points are also novel:—A clip load—five shots— a hooded bead foresight, a backsight with wind gauge, and a complete wood casing for the barrel. The muzzle velocity is rather lower, and the lands are eased off towards the muzzle. This latter innovation is in order to lessen the metallic fouling at the muzzle, and also to center the bullet better. Cordite M. D. is to be used, thereby lessening the erosion, and so giving a longer life to the barrel. In shortening the rifle to make it available for the mounted man as well as for the foot soldier, we are supported by both the United States and Japan. The new rifle has been tried and found exceedingly accurate at 500 and 600 yards, the most important ranges on service, and its rapidity of fire is very much in advance of the older arm.

In spite of the adverse criticisms from various sources with which the new arm has been assailed, it is confidently believed by those in a position to judge, that it will easily justify its introduction, and that the sacrifice of a few inches of barrel and a few feet of muzzle velocity will be more than outweighed by the gain in other directions. It may be mentioned here that the difference in the maximum vertical ordinates at 500 or 1000 yards between the old and new rifle are only 4 inches and 12 inches respectively. The wind gauge on the back sight has only been adopted after very strenuous efforts on the part of its advocates. As an answer to the objections which some have raised to its adoption on the ground that it is to delicate for service, it may be mentioned that 20,000 rifles with similar wind gauges were used by the United States in Cuba without any going wrong.

It is to be noted that the service bullet has again failed as a man-stopper in Somaliland. It is devoutly to be hoped that no false sentiment will keep us from adopting an expanding bullet of some sort for all warfare of this description. The "lead pencil" is absolutely unsuitable for use against savages, and it is only a false humanity which insists on its employment.

—*Engineer*, January 1, 1904.

Examinations for Gunners.

To the Editor of the Artillery Journal, Fort Monroe, Va.

I notice in your September-October number, 1903, an article entitled "Examinations for Gunners" by Captain Robert E. Wyllie, Artillery Corps, to which, while subscribed to by me, I desire to add the following.

For the past two years I have been a member of the examining board for gunners in this artillery district, and without criticism of the authority convening these boards I would like to call attention to the disadvantages of the present system, at two company posts, of having the company commanders and company officers examine the men of each others companies.

Human nature is pretty much the same the world over, and is not different in the case of an enlisted man.

Why then, where two companies are serving side by side, and there is a keen sense of rivalry between them, as there is sure to be between any two self-respecting companies so situated, is it not quite natural for the men to feel that their examiner is not entirely unbiased in conducting the examination ?

Every company commander has his own methods of instruction and of expounding the lessons, which differ materially in many cases from the methods used in the adjacent company. An enlisted man is not always bright enough to see that the general tenor of the questions asked by the examiner are the same as taught him by his commander, when questions that have been taught him in one form are asked him in another; and what is more natural for him than to think that this officer is making things unnecessarily difficult on purpose, and that under the circumstances he is not having a fair chance to display what he knows?

Moreover is an officer so situated liable to be entirely unprejudiced? He takes an active personal interest in the showing his own company can make compared with the other one and realizing this, endeavors to be absolutely impartial and upright, but who can really say he is not, in his own endeavor, bending one way or another?

I have repeatedly discussed this phase with my brother company commander, in conducting these examinations, and I can state that his views on this subject are similar to mine.

If general examining boards were appointed to cover a fairly wide locality, all this would be obviated and there could be absolutely no chance of such a state of affairs existing, and all companies would get exactly the same examination, be it hard or easy.

P. C. HAINS, Jr.,
Captain, Artillery Corps.

Jackson Bks, La., Nov. 17, 1903.

BOOK REVIEWS.

Reminiscences of the Civil War. by General John B. Gordon of the Confederate Army. With portraits. New York: Charles Scribner's Sons. 1903.

The work before us is the latest that consists of personal reminiscences of the Civil War, and is one of the most interesting as well as entertaining of them all. It is written in a spirit of kindly feeling to all, North and South, Yankee and Confederate, and with a generosity of soul worthy of the great soldier and the courtly Southern gentlemen, the author. His praises are bestowed on both sides alike, and his criticisms are as severe on Confederates as on Union Soldiers. To quote his own words:

"It will be found, I trust, that no injustice has been done to either section, to any army, or to any of the great leaders, but that the substance and spirit of the following pages will tend rather to lift to a higher plane the estimate placed by victors and vanquished upon their countrymen of the opposing section, and thus strengthen the sentiment of intersectional fraternity which is essential to complete national unity."

These *reminiscences* are exceedingly personal in character, and thus all the more charming, for the author (as well as the events) is interesting, besides being bright and witty, and has an excellent command of language, understanding well the powers of rhetoric, but above all he is very *human* and appeals to us on that account more than any other. After closing the volume the reader feels that he has become acquainted with another true gentleman, strong for the Right and the Good, but more than that, he has learned to love a chivalrous soldier, with a great heart, full of kindly feeling for his brother man.

General Gordon was the last of the great commanders on the Southern side in the Civil War, and as we are writing this brief notice of his work, he too has passed away.

Throughout the volume, besides the great events occurring, we have the author's own life and his progress from the opening of the war when he was a Georgia lawyer prospecting coal mines in the mountains of his state, where he organized a company to enter the war, until the surrender at Appomattox, where Longstreet and he commanded what was left of Lee's army. General Gordon was but thirty-three years of age when the war closed.

Historically the most interesting chapters are those relating to Cedar Creek, Antietam, Gettysburg and the Wilderness, but there are also interspersed estimates of the characters of many of the great soldiers of the war: Lee, Ewell, Grant, Thomas, Sheridan, Sherman, Longstreet, McClellan, Stonewall Jackson, Rosecrans, Hancock, A. P. Hill and others.

General Gordon's *Reminiscences* will take their place by the side of the great memoirs of this momentous struggle, and have added much valuable matter for the historian, but more than all they point the way for the future historian of the war and indicate the spirit in which its history should be written.

Notes and Reminiscences of a Staff Officer: Chiefly relating to the Waterloo Campaign and to St. Helena Matters During the Captivity of Napoleon. By Lieut.-Col. Basil Jackson. New York: E. P. Dutton & Co. London: John Murray. 1903. Pp. 218.

This modest and unassuming contribution to the literature of Waterloo and St. Helena is a real addition of considerable value, besides being very entertaining reading. Much as has been written on these two great subjects, the world is still always interested in the appearance of something new or additional, that gives it a clearer view of these ever living scenes.

Colonel Jackson was a staff officer at Waterloo and was afterwards on duty at St. Helena, so that he necessarily saw much that was worth seeing, but, as appears in the sequel, he had more than ordinarily good opportunities for observation.

In the *Introduction* the editor (Mr. R. C. Seaton, M. A.) says:

"These *Notes and Reminiscences* were printed for private circulation in 1877, the author not thinking that they were of sufficient interest to justify publication. The reader will probably be of a different opinion. They are now published by the kind permission of Mrs. Simcoe, of Wolford, Devon, the author's daughter."

Colonel Jackson graduated at the Military college at the age of sixteen, but was allowed to remain six months more at college to further prosecute his studies, and was then transferred to the Royal Staff Corps. He joined the headquarters of his Corps at Hythe early in 1812, and towards the end of the following year was ordered to serve on the staff of the Quartermaster-General (a kind of Chief of the General Staff in those days) in Holland, where he gained considerable experience in the operations against French garrisons remaining in that region.

In 1814 the French abandoned the territory, and the division to which Colonel Jackson was attached was quartered in Belgium, where it eventually formed the nucleus of the army at Waterloo.

As staff officer, Colonel Jackson's duties required him to visit the principal towns in Belgium in order to determine their capacity for quartering troops in them, and in this way he became thoroughly familiar with every portion of this historic theatre of operations. On one occasion he was directed to investigate the roads of the country, and made a special report on the route by which the Prussians retired after the battle of Ligny. This report was transmitted to General Gneisenau, and undoubtedly helped to form his speedy decision to retreat northward by a by-road to Wavre immediately after the defeat.

The social life at Brussels, just before the campaign, is well described, but the greatest interest, of course, of this part of the author's reminiscences attaches to the scenes on the field of battle. As a staff officer he not only assisted in preparing the orders on the evening of June 15, 1815, but also rode out to deliver some of them in person, and on his way back met a number of the officers coming from the Duchess of Richmond's ball, and, from his familiarity with the ground and his knowledge of the position of the troops, was able to direct them by the shortest route to their respective organizations.

But it is impossible to go into all the details of this great battle, suffice it to say that Colonel Jackson saw much and reported what he saw intelligently and simply, and yet with a fascinating grace.

Let us quote a few words from the description of the field of Quatre Bras after the fight there:

"The ground was strewed with battered helmets, damaged cuirasses, broken swords and muskets, shattered gun-carriages, and other signs of fierce strife; and that it had been a bloody contest was shown by the manly form of many a bold cuirassier, lying stretched by the side of a dead opponent.

* * * * *

"I then rode towards the advanced posts in front of our left, passing over the ground where the 42nd Highlanders had been surprised by the cuirassiers, who, concealed by the tall rye, were upon them before they could even think of forming square. Here lay many of the 'unreturning brave,' whom I had seen leave Brussels full of 'high hope' but a few short hours before."

There are many interesting reminiscences of Wellington, Blücher and others in these pages, besides some valuable notes on the events, which proceed through the battle of Waterloo and thence follow the army to Paris.

In October, 1815, the author was ordered to St. Helena to report to the Governor there, so that he remained associated with the center of interest at this time. His impressions of the Emperor, of the Governor, and of the other important personages at St. Helena, and his descriptions of the life there are very entertaining reading, and throw new light on many disputed points, besides having the charm that usually attaches to *personal* reminiscences.

The volume is neatly bound, illustrated by a number of historical views, and printed in large type on heavy paper.

Historischer Rückblick auf die Verpflegung der Armeen im Felde. IV. Lieferung. Oberst Otto Meixner. 1904. Wien: L. W. Seidel und Sohn. 6 Marks.

The fourth part of this excellent treatise on the supply of armies in the field attempts to record the history of this important subject so far as it relates to the campaign of 1870-71.

The greatest difficulty which the author met with was the correlation of the mass of material on the subject, and the absence of any connected data referring to the entire army, combined with the fact that the field orders were no longer available for consultation.

But by means of the large amount of literature recently published, relating to the war, he has been able to supply the deficiencies in part and thus produce a fairly exhaustive account.

An appendix containing a brief summary of the events aids materially the understanding of the subject.

The work opens with a description of the theatre of operations, with special reference to supplies and communications; then considers the organization of the armies as regards the supply troops, field railroads and wagon trains; and finally takes up the subject of the system of supply, including requisition, rations, supply trains, field bakeries, and fresh meat supply.

The preparations for war, mobilization, and strategic deployment are next considered in their relations to the subject in hand, and the mode of supply is then carefully traced in each army as it advances in the operations.

The important features of this work have been previously discussed, in reviews of preceding parts of the general treatise, and it is hardly necessary to add anything here. It is unique in its treatment of the subject, and constitutes a most valuable and reliable work of reference on this subject of vital importance to armies.

The New International Encyclopaedia. Editor: D. C. Gilman, LLD., President of John Hopkins University and of Carnegie Institution; H. T. Peck, Ph. D., Professor in Columbia University; F. M. Moore, M. A., Professor in New York University. Volumes XI, XII, XIII and XIV. New York: Dodd, Mead and Company, 1903.

These four latest volumes of this great work carry the latter to the word *Rice-Bird*, and bring it well towards completion. The high character of the work is maintained throughout, and these recent additions are quite as satisfactory as their predecessors.

Volume XI. contains the usual number of colored plates of great beauty and excellence. The maps include four of our states, one of our cities, and one of London, and of greatest interest is a new map of Central Luzon, covering a double page, with a separate map of Manila on a larger scale.

The engravings comprise some fine portraits, such as Robert E. Lee, Marshall's portrait of Abraham Lincoln, and one of Martin Luther; photographs of architecture and other works of art, and the usual plates illustrating the scientific and general articles are also included in the volume.

Among the larger articles are two very interesting ones on Latin Language and Literature, a very lucid one on Latitude and Longitude, one on Magnetism, another on the Locomotive, a good one on Leather, one containing a clear exposition of the subject of Light, one on Law, and an excellent one on Libraries, besides others of more or less general interest. There are also some very interesting shorter articles, containing much entirely new matter.

The military articles comprise quite a number in this volume, such as Lieutenant, Lieutenant-Colonel, Lieutenant-Commander, Lieutenant-General, Major, Major-General, Man-of-War, Manual of Arms, Marching, Life Guards, Marine Corps, Laws and Usages of War, Martial Law, Battles of Leipzig, Malven Hill, Marengo, Robert E. Lee, Longstreet, Massena, Marlborough, Limber, Loading Tray, Machine Gun, Magazine, Magazine Gun, Mauser Gun and Maxim Gun, besides the military historical, geographical and biographical articles too numerous to mention. Many of these subjects are illustrated, and all that admit of it are brought up to date and are quite modern.

The other volumes correspond in general character to Volume XI., and it is therefore unnecessary to analyse them in detail, but we desire to call special attention to the artistic features of these volumes, for in its illustrations the Encyclopaedia is a perfect storehouse of art and beauty.

There are many fine colored plates of great beauty and delicacy, and most interesting engravings of famous works of art, besides many others, comprising the great cathedrals, portraits by distinguished painters, architecture, etc., all selected with great taste and presented so beautifully as to please the most esthetic.

The military articles are also numerous and interesting, especially those on Pistols and Revolvers, Ordnance, Recruitment, and Mountain Artillery. In general, they are brought well up to the present time.

The work as a whole is perhaps the most generally useful encyclopaedia of the present time, as well as one of the most instructive, not only in the domain of the Useful, but also in that of the Beautiful.

America in the China Relief Expedition. By Brigadier-General A. S. Daggett, U. S. Army, Retired. 267p. Illustrations and maps. O. Kansas City: Hudson-Kimberly Publishing Co. 1903.

General Daggett who as Colonel commanding the 14th Infantry bore such a conspicuous part in this expedition, presents in this book a very entertaining account and graphic picture of the brilliant part taken by the United States troops in this remarkable campaign. Most writers on this subject have attempted to cover the whole field of operations, and have left out, necessarily perhaps, much that the American forces did which ought to be preserved, hence the author's aim has been to give in convenient and concise form a more detailed account of America's share in this expedition than has hitherto appeared. He confines himself to statements of facts and all the facts, so far as it was possible to obtain them, drawing on his own personal experience and observation, official reports and documents, and the personal observations of officers serving with the American forces engaged. The result is that his book gives a detailed narrative of this interesting, and in many respects unique, campaign, concisely and explicitly written and, besides, having the interest to a great extent of personal reminiscences.

The book opens with a brief introduction of the early history of the causes which led up to the Boxer uprising, and then commencing from the time of the first landing of the marines at Taku on May 29, until the withdrawal of the forces from Peking, it gives a clear and interesting account of the movements and accomplishments of the United States troops, with sufficient reference to the foreign contingents to make the narrative intelligible. General Daggett had more than ordinarily good opportunities for observation, and his work abounds in personal references to the deeds of men and officers but he justly limits himself to the plain statement of the facts as seen or reported.

In addition to its value as an historical account of the events described, now and then through the book are to be found the reflections and opinions of the experienced and trained soldier on matters connected with troops in the field, which contribute greatly to the interest of the work. The volume closes with twenty-five appendices comprising the most important official documents relating to the expedition.

The book is neatly bound in blue cloth and is well and generously illustrated, including several maps, one of which is of large size showing the whole section of North China in which the uprising occurred.

This history forms a valuable and reliable contribution to American military history and is very well worth reading.

A Guide to the Chemical Analysis of Water. By M. M. Cloud, M. D., 1st Lieutenant, Medical Department, U. S. A, (retired). 24p. T. Kansas City: Hudson-Kimberly Publishing Co. 1903.

This little work should prove of much value to the student both in the laboratory and in practical work as it gives in concise and connected form the essentials of the chemical analysis of water, or more strictly speaking, a series of experiments to determine the presence or absence for the time being of certain constitutents in the water upon which experts base an opinion as to the character of the water under examination.

It has been compiled by the author from notes taken in the laboratory of the Army Medical School, Washington, D. C. The author also acknowledges the use made of Mason's "Water Supply", but this little manual possesses the advantage of enabling the student to do his work without being compelled to read through the larger and more cumbersome volume.

The apparatus required is given and the steps of the various experiments are concisely and clearly indicated.

EXCHANGE AND BOOK NOTICES.

Practical Field Exercises in Tactics and Strategy: For the Use of the Regular Army and the Militia. By Major John P. Wisser, Artillery Corps, U.S. A. 265 p. maps and 23 maps in separate case. O. Kansas City: Hudson-Kimberly Publishing Co. 1903.

Taschenbuch der Kriegsflotten. V. Year, 1904. B. Weyer, Kapitanleutnant a D. 341 p. S. With 311 plates and pictures of ships. München: Verlag von J. F. Lehman. 1903.

The Tactical Employment of Quick-firing Field Artillery. Translated from the French of Gabriel Roquerol, Major in the 16th Regiment of Artillery. by Captain P. de B. Radcliffe, R. F. A. 16 + 233p. Maps. D. London, Hugh Rees, Ltd. 1903.

The Craftsman for January amply fulfils the expectations raised by announcements, made as to its increased scope during the current year. Its contents include the following interesting articles: The Franciscan Mission Builders of California, fully illustrated; The Silversmith's Art: The Sixteenth, Seventeenth and Eighteenth Centuries, with many attractive illustrations; The Importance of Municipal Improvements; The Workingman's Dwelling in France: A Craftsman House: Series of 1904, No. 1, Illustrated; Manual Training and Citizenship,—and, in addition, others on art and handicraft.

With the issue for January, 1904, the **Book Lover** becomes a monthly magazine. This change in frequency of issue is directly in the line of improvement which has marked this magazine from its first number, and is accompanied by further and material improvements in both text and illustration. A more convenient page size has been adopted and the number of pages is increased to 128.

The contents of this number are many and varied and offer much delightful reading to all interested in books and the arts.

The magazine is published by the **Book Lover Press**, East 21st Street, New York. Subscription price, $3.00 per year, of twelve numbers.

INDEX TO CURRENT MILITARY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Arms and Explosives. [*Arms and Expl.*] *Monthly.*
Effingham House, *Per year* 7 *s.*
Arundel Street, Strand, London, W. C.

Army and Navy Gazette. [*A. & N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden,* *Per year* £1 12*s* 6 *d.*
London. W. C.

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
232 *McGill Street,* *Per year* $2.00.
Montreal, Canada.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand,* *Per year* £2 6 *d.*
London, W. C.

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand,* *Per year* £2 6 *d.*
London, W. C.

Journal of the Royal United Service Institution. *Monthly.*
Whitehall, London, S. W. [*Jour. R. U.S.I.*] *Per year* 24 *s.*

Journal of the United Service Institution of India. *Quarterly.*
Simla, India. [*Jour. U. S. I. India*] *Per year* $2.50.

Page's Magazine. [*Page's Mag.*] *Monthly.*
Clun House, *Per year* 16 *s.*
Surrey Street, Strand, London, W. C.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
66 *Russell Square, London.* *Per year* 12 *s.*

Proceedings of the Institution of Civil Engineers. *Annual.*
25 *Great George Street,* [*Proc. I. C. E.*]
Westminister, London, S. W.

Proceedings of the Institution of Mechanical Engineers.
Storey's Gate [*Proc. I. M. E.*]
St. James' Park,
Westminister, London, S. W.

Proceedings of the Royal Artillery Institution. *Monthly.*
Woolwich, England. [*Proc. R. A. I.*]

Professional Papers of the Corps of Royal Engineers.
Chatham, England. [*Prof. Papers C. R. E.*]

Review of Reviews. [*Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia.* *Per year* 10 s. 6 d.

Transactions of the Canadian Institute. *Annual.*
58 *Richmond Street,* [*Trans. Can. Inst.*]
Toronto, Canada.

Transactions of the Canadian Society of Civil Engineers.
Montreal, Canada. [*Trans. Can. Soc. C. E.*]

Transactions of the Institute of Naval Architects.
5 *Adelphi Terrace,* [*Trans. Inst. N. A.*]
London, W.C.

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
245 *Dashwood House,* *Per year* £1 10 *s* 6 *d.*
New Broad Street, London, E. C.

United Service Magazine. [*U. Serv. Mag.*] *Monthly.*
23 *Cockspur Street, Charing Cross,* *Per year* 27 *s.*
London, S. W.

FRANCE.

Armée et Marine. [*A. Marine.*] *Weekly.*
26, *Boulevard des Italiens, Paris,* *Per year* 35 *Fr.*

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris.* *Per year* 45 *Fr.*

La Marine Française. [*Marine F.*] *Semi-monthly.*
26 *Rue de Grammont, Paris.* *Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
19 *Rue Blanche,* [*Memoires I. C.*] *Monthly.*
Paris. *Per year* 36 *Fr.*

Memorial des Poudres et Salpêtres. *Semi-annually*
Quai des Grands-Augustins, 55 *Per year* 13 *Fr.*
Paris, France. [*M. Poudres.*]

Le Monde Militaire. [*Monde.*] *Fortnightly.*
6 *Rue de la Chaise, Paris.* *Per year* 8 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris.* *Per year* 22 *Fr.*

Revue de Cavalerie. [*R. Cav.*] *Monthly.*
5 *Rue des Beaux-Arts* 5, *Paris.* *Per year* 53 *Fr.*

Revue du Cercle Militaire. [*Cercle.*] *Weekly.*
37 *Rue de Bellechasse, Paris.* *Per year* 27 *Fr.*

Revue du Génie Militaire. [*R. Génie M.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris.* *Per year* 27 *Fr.*

Revue d'Infanterie. [*R. Inf.*] *Monthly.*
10 *Rue Danton, Paris.* *Per year* 25 *Fr.*

Revue Maritime. [*R. Maritime.*] *Monthly.*
Rue et Passage Dauphine 30, *Paris.* *Per year* 56 *Fr.*

Revue Militaire des Armées Etrangères. *Monthly.*
R. Chapelot et Cie., [*R. M. Etrang.*] *Per year* 15 *Fr.*
Rue et passage Dauphine 30, *Paris.*

Revue Militaire Universelle. [*R. Univ.*] *Monthly.*
10 *Rue Danton, Paris.* *Per year* 25 *Fr.*

Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
55 *Rue de Chateaudun, Paris.* *Per year* 30 *Fr.*

GERMANY.

Beiheft zum Militaer-Wochenblatt. *Occasional.*
Koch Strasse, 68, [*Beiheft zum M. W.*]
Berlin. S. W., 12.

Internationale Revue. *Weintraubenstrasse* 21, 1. *Dresden–N.*	[*Int. Rev.*]	*Monthly.* *Per quarter* 8 *Fr.*
Jahrbuecher fuer die deutsche Armee und Marine. *Mohren Strasse*, 19, *Berlin*, *W.* 8.	[*Jahrbuecher.*]	*Monthly.* *Per year* 24 *M.*
Kriegstechnische Zeitschrift. *Koch Strasse*, 68-71, *Berlin*, *S. W.*	[*Kriegstech.*]	*Ten numbers a year.* *Per year* 10 *M.*
Marine Rundschau. *Koch Strasse*, 68-71, *Berlin*, *S. W.*	[*Rundschau.*]	*Monthly.* *Per year* 8 *M.*
Militaer-Wochenblatt. *Koch Strasse*, 68, *Berlin*, *S. W.* 12.	[*Wochenblatt.*]	*Semi-weekly.* *Per Year* 20 *M.*
Schiffbau. *Emil Grottke's Verlag*, *Wilhelmstrasse* 105, *Berlin*, *S. W.*	[*Schiffbau.*]	*Semi-monthly.* *Peryear* 18 *M.*
Stahl und Eisen. *Jacobistrasse* 5, *Düsseldorf.*	[*Stahl u. Eisen.*]	*Fortnightly.* *Per year* 24 *M.*
Ueberall. *Verlag: Boll and Pickardt*, *Georgenstrasse* 23, *Berlin*, *N. W.*	[*Ueberall.*]	*Weekly.* *Per year M.* 23.60.
Die Umschau, *H. Bechhold Verlag*, *Frankfort A. M.*	[*Umschau.*]	*Weekly.* *Per year M.* 21.20.

AUSTRIA.

Mittheilungen aus dem Gebiete des Seewesens. *Pola.*	[*Seewesens.*]	*Monthly.* *Per year* 17 *M.*
Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens. *Getreidemarkt* 9. *Wien. VI.*	[*Mitth. Art. u. G.*]	*Monthly.* *Per year* 20 *M.*
Organ der Militaer Wissenschaftlichen Vereine. *Strauchgasse No.* 4 *Wien I.*	[*Organ.*]	8-14 *numbers.* *Per year* 20 *K.*
Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines. *Eschenbachgasse*, *No.* 9. *Wien. I.*	[*Zeitschr. I. A. V.*]	*Weekly.* *Per year* 30 *K.*

SWITZERLAND AND BELGIUM.

Allgemeine Schweizerische Militaer-Zeitung. *Basel*, *Switzerland.*	[*A.S.M. Zeit.*]	*Weekly.* *Per year*, 8 *Fr.*
La Belgique Militaire. *Rue Albert de Latour*, 50, *Schaerbeek*, *Brussels.*	[*Belgique M.*]	*Weekly.* *Per year F.* 12.50.
Revue de l'Armée Belge. 22 *Rue des Guillemins*, *Liège*, *Belgium.*	[*A. Belge.*]	*Bi-monthly.* *Per year* 13 *Fr.*
Revue Militaire Suisse. 23 *Escaliers-du-Marché*, *Lausanne*, *Switzerland.*	[*R. M. Suisse.*]	*Monthly.* *Per year Fr.* 12.50.
Schweizerische Militärische Blätter. *Frauenfeld*, *Switzerland.* Includes: **Monatschrift fuer Offiziere Aller Waffen.** **Zeitschrift fuer Artillerie und Genie.**	[*S. M. Blaetter.*]	*Monthly.* *Per year* 12 *Fr.*

ITALY AND RUSSIA.

Rivista di Artiglieria é Genio.	[*R. Artig.*]	*Monthly.*
Tipografia Enrico Voghera, *Via Astalli* 15, *Rome.*		*Per year* 30 *L.*
Rivista Marittima.	[*R. Maritt.*]	*Monthly.*
Economo del Ministero della Marina, *Rome.*		*Per year* 25 *L.*
Voyennyj Sbornik.	[*Sbornik.*]	*Monthly.*
Madezhcdinskoi Dom. No. 21, *St. Petersburg, Russia.*		*Per year* 4.80.

HOLLAND AND SCANDINAVIA.

Artilleri-Tidsskrift.	[*Art. Tids.*]	*Bi-monthly.*
Artillerigärden Stockholm, Sweden.		*Per year, U. S.,* $1.75
De Militaire Gids.	[*M. Gids.*]	*Bi-monthly.*
De Erven F. Bohn, Haarlem, Holland.		*Per year, U. S.,* $2.00
Militaert Tidsskrift.	[*M. Tids.*]	*Bi-monthly.*
Copenhagen, Denmark.		*Per year, U. S.,* $2.50
Norsk Artilleri-Tidsskrift.	[*N. Art. Tids.*]	*Bi-monthly.*
Christiania, Norway.		*Per year* $1.50.
Norsk Militaert Tidsskrift.	[*N. M. Tids.*]	*Monthly.*
Christiania, Norway.		*Per year, U. S.,* $2.50

SPAIN, PORTUGAL, MEXICO AND SOUTH AMERICA.

Annaes do Club Militar Naval.	[*Club Mil. Nav.*]	*Monthly.*
43 *Rua do Carmo, Lisbon, Portugal.*		*Per year* $3.85.
Boletin del Centro Naval.	[*Boletin.*]	*Monthly.*
Florida 659 *Buenos Aires, Argentina.*		*Per year* $\$^{m}/_{n}$ 11.00.
Liga Naval Portuguesa,	[*Liga Nav.*]	*Monthly.*
95 *Rua Garrett,*	*Lisbon Portugal.*	*Per year* $4.50.
Memorial de Artilleria.	[*M. de Art.*]	*Monthly.*
San Lorenzo 5, *bajo, Madrid, Spain.*		*Per year,* $3.60.
Revista Cientifico-Militar.	[*Cientifico.*]	*Semi-monthly.*
5 *Calle de Cervantes, Barcelona, Spain.*		*Per year* 40 *Fr.*
Revista de Engenheria Militar.	[*Eng. Mil.*]	*Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal.*		*Per year* 16 *Fr.*
Revista do Exercito e da Armada.		*Monthly.*
Largo de S. Domingos 11, *Lisbon, Portugal.*	[*Exercito.*]	*Per year U. S.* $6.00.
Revista General de Marina,	[*R. G. de Marina.*]	*Monthly.*
56 *Calle de Alcalá, Madrid, Spain.*		*Per year* $4.45.
Revista de Marina.	[*R. de Mar.*]	*Monthly.*
Casilla del Correo 976, *Valparaiso, Chili.*		*Per year* $10.00.
Revista Maritima Brazileira.	[*R. Marit. Brazil.*]	*Monthly.*
Rua Conselheiro Saraiva n. 12, *Rio de Janeiro, Brazil.*		*Per year* $6.60.
Revista Militar.	[*R. Mil. Portugal.*]	*Semi-monthly.*
262 *Rua da Princeza, Lisbon, Portugal.*		*Per year,* $2.60.
Revista Militar.	[*R. Mil. Brazil.*]	*Monthly.*
Rio de Janeiro, Brazil.		

UNITED STATES.

American Electrician. 120 *Liberty Street, New York.*	[*Amer. Elec.*]	*Monthly.* *Per year* $1.00.
American Journal of Mathematics. *Johns Hopkins University,* *Baltimore, Md.*	[*Jour. Math.*]	*Quarterly.* *Per year* $5.00.
American Machinist. 256 *Broadway, New York City.*	[*Amer. Mach.*]	*Weekly.* *Per year* $3.00.
American Manufacturer and Iron World. 55 *Ninth Street,* *Pittsburgh, Pa.*	[*Amer. Manfr.*]	*Weekly.* *Per year* $4.00.
Army and Navy Journal. *New York City.*	[*A. & N. Jour.*]	*Weekly.* *Per year* $6.00.
Army and Navy Register. *Washington, D. C.*	[*A. & N. Reg.*]	*Weekly.* *Per year* $3.00.
Bulletin of the American Mathematical Society. *University Heights,* *New York City.*	[*Bulletin Math. Soc.*]	*Ten numbers per year.* *Per year* $5.00.
Cassier's Magazine. 3, *West 29th Street, New York City.*	[*Cas. Mag.*]	*Monthly.* *Per year* $3.00.
Electrical World and Electrical Engineer. 114-118 *Liberty Street,* *New York City.*	[*Elec. World.*]	*Weekly.* *Per year* $3.00.
Electrical Review. 41 *Park Row, New York City.*	[*Elec. Rev.*]	*Weekly.* *Per year* $3.00.
The Engineer. 355 *Dearborn Street, Chicago, Ill.*	[*Eng. C.*]	*Fortnightly.* *Per year* $2.00.
Engineering Magazine. 120-122 *Liberty Street, New York City.*	[*Eng'ing. Mag.*]	*Monthly.* *Per year* $3.00.
Engineering and Mining Journal. 261 *Broadway,* *New York City.*	[*Eng. and Min. Jour.*]	*Weekly.* *Per year* $5.00.
Engineering News and American Railroad Journal. 220 *Broadway,* *New York City.*	[*Eng'ing News.*]	*Weekly.* *Per year* $5.00.
The International Quarterly. *Burlington, Vt.*	[*Int. Quart.*]	*Quarterly.* *Per year* $3.00.
The Iron Age. 232-238 *Williams Street, New York City.*	[*Iron Age.*]	*Weekly.* *Per year* $4.50.
Journal of Electricity. 144 *Union Square Ave, San Francisco, Cal.*	[*Jour. Elec.*]	*Monthly.*
Journal of the American Chemical Society. *Easton, Pa.*	[*Jour. Chem. S.*]	*Monthly.* *Per year* $5.00.
Journal American Society of Naval Engineers. *Navy Department,* *Washington, D. C.*	[*Jour. A.S.N.E.*]	*Quarterly.*
Journal of the Association of Engineering Societies. 257 *South Fourth Street,* *Philadelphia.*	[*Jour. Eng. Soc.*]	*Monthly.* *Per year* $3.00.

Journal of the Association of Military Surgeons. *Carlisle, Pensylvania.*	[*Jour. Mil. Surg.*]	*Monthly.* *Per year* $3.00.
Journal of the Franklin Institute. *Philadelphia, Pa.,*	[*Jour. Frank. Inst.*]	*Monthly.* *Per year* $5.00.
Journal of the Military Service Institution. *Governor's Island,* *New York City.*	[*Jour. M. S. I.*]	*Bi-monthly.* *Per year* $3.00.
Journal of the U.S. Cavalry Association. *Fort Leavenworth, Kan.*	[*Jour. U. S. Cav.*]	*Quarterly.* *Per year* $2.00.
Journal of the Western Society of Engineers. 1737 *Monadnock Block,* *Chicago, Illinois.*	[*Jour. W. Eng.*]	*Bi-monthly.* *Per year* $2.00.
Marine Review. *Cleveland, Ohio.*	[*Mar. Rev.*]	*Weekly.* *Per year* $2.00.
Military Information Division. *War Department, Washington, D. C.*	[*Mil. Inf. Div.*]	*Quarterly.*
Mines and Minerals. *Scranton, Penn.*	[*Mines. and Min.*]	*Monthly.* *Per year* $2.00.
The National Guardsman. 134 *Van Buren Street, Chicago, Ill.*	[*N. Guard.*]	*Monthly.* *Per year* $1.00.
Pennsylvania Magazine of History and Biography. 13 *Locust Street,* *Philadelphia.*	[*Penn. Mag.*]	*Quarterly.* *Per year* $3.00.
Physical Review. *Cornell University, Ithaca, New York.*	[*Phys. Rev.*]	10 *numbers per year.* *Per year* $5.00.
Popular Science Monthly. 72 *Fifth Avenue, New York City.*	[*Pop. Sc. Mo.*]	*Monthly.* *Per year* $5.00.
Popular Mechanics. *Journal Building, Chicago, Ill.*	[*Pop. Mech.*]	*Monthly.* *Per year* $2.00.
Proceedings of the American Philosophical Society. 104 *South Fifth Street,* *Philadelphia, Pa.*	[*Proc. A. Phil. Soc.*]	
Proceedings of the American Society of Civil Engineers. 220 *West 57th Street,* *New York City.*	[*Proc. A. S. C. E.*]	*Monthly.*
Proceedings of the Engineers' Club of Philadelphia. 1122 *Girard street,* *Philadelphia, Pa.*	[*Proc. Eng. C. Phila.*]	*Quarterly.* *Per Vol.* $2.00.
Proceedings of the U. S. Naval Institute. *Annapolis, Md.*	[*Proc. Naval Inst.*]	*Quarterly.* *Per year* $3.50.
Review of Reviews. 13 *Astor Place, New York City.*	[*R. of Rev.*]	*Monthly.* *Per year* $2.50.
The Scientific American. 361 *Broadway, New York City.*	[*Scien. Amer.*]	*Weekly.* *Per year* $3.00.
Shooting and Fishing. 293 *Broadway, New York City.*	[*S. and Fish.*]	*Weekly.* *Per year* $3.50.
The Spanish War Journal. 320 *Indiana Ave., Washington, D. C.*	[*Span. War Jour.*]	*Monthly.* *Per year* $1.00.

Technology Quarterly. *Mass. Inst. of Tech., Boston, Mass.*	*[Tech. Quart.]*	*Quarterly.* *Per year, $3.00.*
Telephone Magazine, *Marquette Building, Chicago, Ill.*	*[Tel. Mag.]*	*Monthly.* *Per year $1.00.*
Transactions American Institute of Electrical Engineers. 26 *Cortlandt Street,* *New York City.*	*[Trans. Inst. Elec. E.]*	*Monthly.* *Per year $5.00.*
Transactions American Institute of Mining Engineers. 99 *John Street,* *New York City.*	*[Trans. Inst. Min. E.]*	
Transactions of the American Society of Civil Engineers. 220 *West 57th Street,* *New York City.*	*[Trans. A. S. C. E.]*	
Transactions of the American Society of Mechanical Engineers. 12 *West 31st Street,* *New York City.*	*[Trans. A. S. Mech. E.]*	
Transactions of the Society of Naval Architects and Marine Engineers. 12 *West 31st Street,* *New York City.*	*[N. A. and Marine Eng'rs.]*	
United Service. 49 *Wall Street N. Y. City.*	*[U. Serv.]*	*Monthly.* *Per year $1.00.*
Western Electrician. 510 *Marquette Building, Chicago, Illinois.*	*[West. Elec.]*	*Weekly.* *Per year $3.00.*

[Periodicals of October, November, December, 1903.]

ARTILLERY MATERIAL.

Considerations on the choice and use of explosives in war.—**M. de Art.**, September, October.

Handling of dynamite.—**S. M. Blaetter**, November.

Ammonal explosives.—**Arms & Expl.**, December ; **A. & N. Jour.**, December 19.

Construction of modern wire-wound ordnance.—**M. de Art.**, September, October.

Report on Army ordnance, U. S.—**Iron Age**, November 19.

Late developments in ordnance and armor.—**Cas. Mag.**, October; **Scien. Amer.**, December 12.

Report of the Chief of Ordnance, U. S.—**A. & N. Reg.**, November 21 ; **A. & N. Jour.**, November 14.

New field gun for the British army.—**Scien. Amer.**, November 7.

Rapid-fire gun question in Austro-Hungary.—**S. M. Blaetter**, September-October.

British war experiences with field howitzers.—**S. M. Blaetter**, September-October.

Rapid-fire field guns, Ehrhardt system.—**A. Belge**, July-August, September-October.

Some remarks on the projectile and calibre question of field guns recoiling on carriage.—**Kriegstech.**, 8, 1903.

Result of the field gun tests in Switzerland.—**Kriegstech.**, 8, 1903.

Old and new material of the German field artillery.—**Wochenblatt**, 117, 1903.

Plan for the construction of a shrapnel for attacking shield-protected batteries.—**Wochenblatt**, 118.

Future armament of the German army (field artillery material).—**Cercle**, November 7.

Field howitzers in South Africa.—**R. Artillerie**, October.

A word in conclusion on the subject of shields.—**Sbornik**, October.

Recoil and counter-recoil apparatus for field guns.—**Kriegstech.**, 9, 1903.

Theory of deformation carriages.—**R. Artig.**, October-

Comparative firing tests in Switzerland of the Ehrhardt 5 cm, and Krupp 7.5 cm. field gun.—**R. Artig.**, October.

Re-armament of the field artillery, Switzerland.—**Exercito**, October; **M. de Art.**, October.

Rapid-fire guns.—**M. de Art.**, October.

Some spontaneous cracks in steel projectiles.—**R. Maritt.**, October.

Ehrhardt shells.—**R. Artig.**, November.

Methods of aiming guns (continuation of the article on modern sights, fully illustrated).—**Mitth. Art. u. G.**, 11, 1903.

Modern sights.—**R. de Mar.**, November.

Review of the experiments of the military technical committee on artillery and small arms.—**Mitth. Art. u. G.**, 10, 1903.

AUTOMOBILES, AEROSTATION.

Reconnaissance with motor-cars.—**A. & N. Gaz.**, December 12.

Automobile construction.—**Amer. Mach.**, November 12.

Steam wagons for commercial use.—**Cas. Mag.**, October.

Electric automobiles.—**Scien. Amer.** Supplement., November 7.

Military tractor.—**Eng'ing.**, December 18; **Eng.**, December 18.

Developments in automobile construction.—**Eng'ing.**, December 18.

Automobile train of Col. Renard.—**Genie C.**, December 19.

Military cycling.—**R. M. Suisse**, October.

Motor transport for goods.—**Page's Mag.**, November.

Steam auto car notes.—**Eng.**, December 4, 11.

Motor cars in Paris.—**Eng.**, December 18.

Dr. Greth's airship.—**Scien. Amer.**, November 7.

New Santos-Dumont airship.—**Scien. Amer.**, November 7.

Recent aeronautical progress and the deductions to be drawn therefrom regarding the future of aerial navigation.—**Scien. Amer.** Supplement, November 21.

Tetrahedral kites of Dr. Alex. G. Bell.—**Pop. Sc. Mo.**, December.

Free balloons with small balloon attachment.—**R. Genie M.**, December.

Recent experiments in the art of flight.—**Genie C.**, November 7.

Dirigible balloons in 1903.—**Umschau**, December 19.

The Lebaudy airship.—**Genie C.**, December 5; **Scien. Amer.**, December 5.

Lebaudy airship disaster.—**Scien. Amer.** Supplement, December 19.

On the use of field balloon detachments.—**Mitth. Art. u. G.**, 10, 1903.

German military balloons.—**A. Marine**, December 27.

Dirigible balloon "Ville de Paris".—**Genie C.**, December 26.

BALLISTICS, RANGE FINDING AND POINTING.

Deviations and falling motion of projectiles.—**R. M. Brazil**, September, October.

Resistance of the wind to projectiles.—**S. M. Blaetter,** November.

Caps and penetration formulas.—**R. de Mar.,** September.

Armor for ships, 1897–1900 (tests, etc.).—**R. Maritt.,** November.

Armor perforation formulas.—**R. Artig.,** November.

On the determination of the speed of an enemy (warships).—**Seewesens,** November.

New observation methods and their application for the fire efficiency of position artillery (reconnaissance of the ground and target and observation of fire).—**Organ,** lxvii, 3, 1903.

Service of observation of fire with heavy field howitzers.—**Wochenblatt,** 109, 1903.

Note on errors of aiming in the case of guns mounted on an inclined pivot (more especially field guns and howitzers).—**R. Artillerie,** October.

Use of the Austrian direction scale in indirect fire.—**Mitth. Art. u. G.,** 9, 1903.

On the improvisation of aids to shooting.—**Mitth. Art. u. G.,** 9, 1903.

Apparatus for drill in pointing guns.—**R. de Mar.,** October.

Indirect laying for field batteries by the use of auxiliary aiming points.—**M. de Art.,** November.

CHEMISTRY AND PHOTOGRAPHY.

Manufacture of explosives.—**Eng. & Min. Jour.,** December 24.

Stability tests for nitrocellulose and nitrocellulose powders.—**Genie C.,** November 21; **Scien. Amer.** Suplmt., January 2, 9.

Atomic theory.—**Scien. Amer.** Supplement, December 12, 26.

Continuous photo-printing machines.—**Eng'ing. News,** December 3.

DRILL REGULATIONS, MANEUVERS AND PRACTICE.

The new drill regulations of field batteries, Germany.—**M. de Art.,** September; Austria, October, November.

French field artillery drill regulations.—**Wochenblatt,** 115, 1903; **S. M. Blaetter,** November.

New Italian regulations on individual instruction in the cavalry.—**R. M. Etrang.,** November.

New small arms firing regulations for cavalry, France.—**R. Cav.,** November.

Infantry drill regulations, U. S. Army (bibliography).—**A. & N. Jour.,** January 16.

French small arms firing regulations.—**R. M. Suisse,** October.

Draft of regulations on infantry drill and manuevers.—**R. Inf.,** November.

Expert marksmen and estimators of distance; their utility, means of training them and of employing them.—**R. Inf.,** November.

Study on the provisional drill regulations.—**R. Inf.,** November.

Is our system of musketry instruction up to date?—**Sbornik,** October.

Infantry drill regulations.—**Jour. M. S. I.,** January-February.

Gymnastic regulation for mounted troops.—**Wochenblatt,** 127, 1903.

Military sports.—**R. M. Suisse,** December.

American army maneuvers, 1903; West Point and Fort Riley.—**Wochenblatt,** 128; **A. & N. Jour.,** November 7, 14; **A. & N. Reg.** November 14; **Jour. M. S. I.,** January-February.

Army maneuvers in the East, U. S.—**A. & N. Jour.,** November 21.

Army-Navy maneuvers, 1903, U. S.—**Jour. M. S. I.,** January-February.

Great Britain, grand army maneuvers, 1903.—**Cercle.,** November 28; **Wochenblatt,** 115, 1903.

Results of the English maneuvers, 1903.—**A. S. M. Zeit.**, October 24, 31.

Imperial German maneuvers, 1903.—**Cercle,** October 31, November 14; **Ueberall,** 51, 52, 1903; **R. M. Suisse,** December; **R. M. Etrang.**, December; **S. M. Blaetter,** December.

Notes on the infantry at the German Kaiser maneuvers.—**U. Serv. Mag.**, January.

Maneuvers in Southern Hungary.—**Wochenblatt,** 111, 1903.

Austro-Hungarian army maneuvers, 1903.—**Wochenblatt,** 129, 130, 131, 132.

French grand army maneuvers, 1903.—**A. Belge,** July-August, September-October; **Wochenblatt,** 121, 122, 123.

Course and results of the French army maneuvers.—**A. S. M. Zeit.**, November 21, 28.

Personal observations on the French autumn maneuvers.—**Wochenblatt,** 123.

Italian grand army maneuvers, 1903.—**A. S. M. Zeit.**, October 31; **Wochenblatt,** 118, 119, 124, 125; **Int. Rev. Beiheft,** 46, 1903.

The Italian army maneuvers with respect to the technical troops.—**Kriegstech,** 10, 1093.

Russian grand maneuvers, 1903.—**Int. Rev.**, November.

Grand maneuvers in the Warsaw district, 1903.—**Wochenblatt,** 113.

Swiss grand army maneuvers, 1903.—**Wochenblatt,** 126, 127; **Cercle,** December 5, 12, 19.

Maneuvers of the I. army corps.—**R. M. Suisse,** October.

Thiele maneuvers, Switzerland.—**R. M. Suisse,** November.

Echos of the maneuvers, I. army corps.—**R. M. Suisse,** December.

Belgian grand maneuvers, 1903.—**Belgique M.**, November 29, December 20; **Wochenblatt,** 133.

Maneuvers of the three arms combined, Portugal.—**R. Mil. Portugal,** October 15.

Japanese maneuvers, 1902.—**S. M. Blaetter,** September-October.

Spring maneuvers in South Africa.—**U. Serv. Mag.**, January.

Artillery at the maneuvers.—**U. Serv. Mag.**, November.

Instructional use of maneuvers.—**U. Serv. Mag.**, November.

Reflections on the maneuvers.—**U. Serv. Mag.**, November.

Naval maneuvers.—**Eng'ing.**, November 27.

Naval maneuvers; umpire's report.—**U. S. Gaz.**, November 28.

English naval maneuvers, 1903.—**Rundschau,** November; **Ueberall,** 1, 2, 1903-04; **Exercito,** October.

United States naval maneuvers, August, 1903.—**Rundschau,** November.

German naval maneuvers, 1903.—**Ueberall,** 48, 52.

English torpedo boat maneuvers.—**Ueberall,** 51, 1903.

Naval maneuvers off the coast of Portugal.—**Club Mil. Nav.**, September.

Battle firing of a battery of R. F. guns, Roumanian Army.—**R. Artig.**, October.

On the firing of field batteries.—**M. de Art.**, November.

Results of firing practice of the French field artillery, 1903.—**Kriegstech.**, 10, 1903.

Firing tests of the Russian field artillery.—**S. M. Blaetter,** December.

Battle firing of Russian position artillery.—**S. M. Blaetter,** December.

Experimental formation of machine-gun groups in Austro-Hungary for testing machine guns.—**Wochenblatt,** 113, 1903.

Battle problems at infantry inspections.—**Wochenblatt,** 134.

Some remarks on the execution of small arms firing.—**Belgique M.**, November 1.

Instruction and practice in rifle shooting.—**S. & Fish.**, November 5.

Cavalry training.—**U. S. Gaz.**,November 28; **A. & N. Gaz.**, November 28.

Improvement in naval gunnery, U. S.—**A. & N. Reg.**, January 16.

Gunnery and torpedo training in the navy, England.—**U. S. Gaz.**, December 26.

Considerations on gun fire from warships and means of instructing gunners economically.—**R. G. de Marina**, November.

A new pointing machine.—**R. de Mar.**, October.

Artillery fire from ships, (training and practice).—**Int. Rev.**, Supplement, 56.

ELECTRICITY.

Recent improvements in space telegraphy.—**West. Elec.**, November 7.

Geometric telegraph —**West. Elec.**, November 7.

Relative reliability of wireless and wire telegraph systems.—**Elec. World**, November 14.

Transmitters.—**Tel. Mag.**, November.

New Fessenden wireless telegraph patents.—**Elec. World**, November 21.

Transposition of telephone lines: cross talk and induction.—**Elec. World**, November 21.

Recent progress abroad in wireless telegraphy.—**Elec. World**, November 28.

Practical aspects of wireless telegraphy.—**Umschau**, November 28.

Work of the Signal Corps, U. S., at home and abroad.—**West. Elec.**, November 21, 28.

Lodge-Muirhead system of wireless telegraphy,—**Umschau**, December 12.

Telephone engineering: aerial cable lines.—**Amer. Elec.**, November.

Stelje's type-printing telegraph.—**Scien. Amer.**, November 7.

New experiments in syntonic wireless telegraphy in the Italian navy.—**Scien. Amer.**, Supplement, November 28.

Hertzian wave wireless telegraphy.—**Pop. Sc. Mo.**, December.

Telephone transmitters.—**Elec. World**, December 5, 26.

Directing waves in wireless telegraphy.—**Elec. World**, December 5.

Recent developments in multiplex telephony.—**Elec. World**, December 5.

De Forest system of wireless telegraphy.—**Page's Mag.**, December.

Recent improvements in telephone apparatus.—**West. Elec.**, December 26.

New radio-telegraphic apparatus.—**R. Artig.**, November.

Multiplex telephony, Mercadier system.—**R. Genie M.**, December.

Telephony and telegraphy by electric projectors.—**R. Genie M.**, December.

Wireless telegraphy.—**R. G. de Marina**, December.

Telegraphy in war.—**Kriegstech.**, 10, 1903.

Field telephony.—**Kriegstech.**, 9, 1903.

Electrical installations in armored forts.—**A. Belge**, July-August.

Electricity in the military and naval services·—**Kriegstech.**, 8, 1903.

The electrical installation of the arsenal of Venice, (excellently illustrated, 20 plates)—**R. Maritt**, October Supplement.

Electric search lights: their use afloat and ashore.—**Cas. Mag.**, November.

Manufacture of incandescent electric lamps.—**West. Elec.**, November 14.

Improved method of testing large alternators under full load conditions.—**Elec. World**, November 14, 28.

Comparative behavior of floating and booster-controlled batteries on fluctuating loads.—**Elec. Rev.**, November 28, December 5; **West. Elec.**, December 19.

Shop testing of motors and generators for commercial service—**Elec. Rev.**, November 7, 14; December 12.

Combined use of alternating and direct current for central station work.—**Elec. Rev.**, November 28.

Asynchonous generators.—**Amer. Elec.**, November.

Tracing and remedy of motor troubles.—**Eng. C.**, November 2.

Synchronizers and parallel operation of dynamos.—**Eng. C.**, December 15.

Series and parallel operation of generators.—**Eng. C.**, December 15.

Voltage regulators for generators.—**West. Elec.**, December 26.

The induction motor and its engineering capabilities.—**Jour. Frank. Inst.**, November.

Practical points in the design of direct-current dynamic-electric machines.—**Jour. Frank. Inst.**, November.

Speed regulation of motors.—**Memoires I. C.**, October.

The coal battery.—**West. Elec.**, November 21.

Faure type accumulators.—**Scien. Amer.**, November 14.

Edison storage battery.—**Eng'ing**, December 11; **Elec. Rev.**, December 12; **Elec. World**, December 12; **Scien. Amer.**, December 26; **West.Elec.**, December 19; **Amer. Mach.**, December 31; **Eng. Mag.**, January.

Elementary principles of alternating currents.—**Eng. C.**, November 16.

Electrical conductivity of commercial copper.—**West. Elec.**, November 28.

Electrical measurements and the Wheatstone bridge.—**Amer. Elec.**, November.

What is electricity?—**West. Elec.**, November 28.

Accurate measurement of small resistances with the Kelvin double bridge.—**Elec. Rev.**, January 2.

ENGINEERING, FORTIFICATIONS.

Effect of loam and clay on cement mortar.—**Eng'ing News**, November 19.

The microscope in engineering: study of the structure of metals.—**Cas. Mag.**, November.

The Buffalo breakwater.—**Proc. A. S. C. E.**, November.

Manufacture and use of concrete.—**Page's Mag.**, December.

Mixing and placing concrete.—**Mines & Min.**, December, January.

Origin and development of armored concrete.—**Scien. Amer.**, Supplement, November 21.

Edison Portland cement company (description of manufacture).—**Iron Age**, December 24; **Eng'ing News**, December 24; **Elec. Rev.**, December 26.

Manufacture of artificial Portland cement.—**Genie C.**, November 28, December 5, 12.

Fatigue of cement products.—**Eng'ing News**, November 5.

The Madagascar railway.—**R. Genie M.**, November, December.

Work of the topographical engineers in France during the 19th century.—**R. Genie M.**, November, December.

On the use of the camera obscura for topographical surveys.—**R. Artig.**, October.

On the resistance of armored concrete flooring.—**R. Genie M.**, November.

Water-tight stone and concrete coverings, Leisz-Zuffer patent.—**Mitth. Art. u. G.**, 11, 1903.

Italy's fortifications (defensive system),—**S. M. Blaetter**, September-October. November, December.

Works completed for the defense of Lisbon, 1859-1876.—**Eng. Mil.**, August, September.

Effect of elongated projectiles on earth and beton.—**Mitth. Art. u. G.**, 9, 1903.

Field fortifications.—**Belgique M.**, December 6.

Bulgaria's fortifications.—**Int. Rev.**, November.

On the installation of torpedo tubes in the harbor forts of Rio de Janeiro and the fortification of the ports of the coasts of Brazil.—**R. Mil. Brazil**, October.

Italian views on permanent fortification and siege warfare.—**Mitth. Art. u. G.**, 10, 1903.

ENGINES, BOILERS, MECHANISM.

Boiler settings.—**Amer. Elec.**, November.

Care of boilers.—**Eng. C.**, December 1.

Sources of error in boiler water treatment.—**Eng. Mag.**, November.

The lead of ignition and the duration of explosions in gas engines.—**Genie C.**, November 14.

Walrath gas engine.—**Eng. C.**, November 16.

Burger automatic gas engine.—**Amer. Elec.**, November.

Diesel engine.—**Proc. I. M. E.**, July, 1903.

Combustion engines.—**Eng. C.**, November 2, December 1, 15.

Governing gas and gasoline engines.—**Scien. Amer.** Supl'm'nt, December 12.

Gas engines.—**Eng'ing.**, December 18.

Science of steam generation.—**Cas. Mag.**, December.

Steam pipes and their connections.—**Iron Age**, December 3.

Notes on packing rings for piston heads.—**Amer. Mach.**, December 24.

Lancaster metallic steam packings.—**Eng'ing.**, December 25.

A new mechanism.—**Eng'ing.**, December 4.

New form of friction clutch.—**Proc. I. M. E.**, July, 1903.

Treatment of shaft spring governors.—**Eng. C.**, November 2.

Indicator diagrams.—**Amer. Elec.**, December.

Theoretical indicator diagrams.—**Eng. C.**, December 1.

METALLURGY.

Unexplained phenomena in the metallurgy of iron and steel.—**S. M. Blaetter**, September-October.

Electrometallurgy.—**M. de Art.**, September, October.

Metallography.—**Umschau**, November 28.

Annealing.—**Amer. Mach.**, November 5.

Manufacture of sound castings by means of thermit.—**Amer. Manfr.**, November 26.

Thermit.—**Amer. Manfr.**, November 26.

Light aluminum alloys.—**Eng'ing.**, November 20; **Scien. Amer.**, Supplement, November 7.

Hadfield's investigations on Wolfram steel.—**Stahl u. Eisen**, December 1.

Mechanical and metallurgical applications of aluminothermics.—**Eng. Mag.**, January; **Amer. Elec.**, December.

New tool steels.—**Eng. Mag.**, January.

Machine tools and high speed steel.—**Amer. Manfr.**, December 31; **Eng. Mag.**, January; **Proc. I. M. E.**, July, 1903; **Eng.**, November 13, 20, 27.

Statistics of the Krupp works.—**Scien. Amer.**, Supplement, November 21.

Note on the microstructure of steel.—**Amer. Manfr.**, December 3.

Brief study of the ferro metals and their electrical manufacture.—**Iron Age**, November 12.

Crucible cast steel and tool steel.—**Eng. C.**, December 1.

Iron and steel (complete account of manufacture, including gun steel and armor plate, with details of these industries, fully illustrated).—**Scien. Amer.**, December 12.

MILITARY GEOGRAPHY.

The Argentine seacoasts.—**Boletin**, August.

Gibraltar.—**Wochenblatt**, 116, 1903.

English routes through Canada to the western harbors of the Pacific and India.—**Rundschau**, November, December.

Canal *des Deux Mers* (connecting the Atlantic and Mediterranean).—**R. G. de Marina**, November.

The new dock yard at Gibraltar.—**Page's Mag.**, November.

Most important mountain railways of the world.—**Mitth. Art. u. G.**, 9, 1903.

Caspian and Persian frontier.—**Sbornik**, October.

Korean railways.—**Sbornik**, October.

Russia on the Black Sea.—**Ueberall**, 1, 1902-04.

The yellow Bosphorus.—**Int. Rev Beiheft**, 45, 1903.

The Teltow canal and its importance for commerce and navigation.—**Schiffbau**, December 8, 23.

Ship canals of the world.—**Mar. Rev.**, December 10; **Scien. Amer.**, December 5.

MILITARY HISTORY.

Effect of artillery fire on the morale of troops (historical examples).—**S. M. Blaetter**, September, October.

Artillery sidelights on the South African war, 1899-1902.—**Wochenblatt**, 112 1902.

Again the artillery in the South African war.—**Wochenblatt**, 120.

The war of 1870-1871.—**S. M. Blaetter**, September, October, November, December.

Remarks on the Chief Commands of the II. and X. army corps on the 15th and 16th of August, 1870.—**Wochenblatt**, 117, 1903.

Napoleon: chief of the army. Ulm.—**Cientifico**, October 1, 15, November 1.

Characteristics of the French army under Napoleon I.—**Wochenblatt**, 127.

Gustavus Adolphus.—**U. Serv.**, January.

Studies of military history: Franco-Spanish invasion of Portugal, 1807.—**Exercito**, October, November.

Battle of Luneburg, April 2, 1813.—**Beiheft zum M. W.**, 10, 1903.

The fighting in Somaliland, 1902-03.—**Wochenblatt**, 114, 1903.

The fighting at Elsasshausen, August 6th, 1870.—**Wochenblatt**, 120.

Studies on the South African war, 1899-1900.—**R. M. Etrang.**, November, December.

Spanish-American war in the Philippines.—**R. Maritime**, October, November.

The eve of Austerlitz.—**A. Marine**, December 6.

Campaign of Kumaon.—**Jour. U. S. I., India**, October.

The Atlanta campaign.—**Jour. U. S. I. India**, October.

How the Sikhs became a militant race.—**Jour. U. S. I. India**, October.

Battle of Forbach, August 6th, 1870.—**Belgique M.**, November 8, 22.

Events in North Africa.—**Wochenblatt**, 124, 1903.

Colenso-Magersfontein.—**Wochenblatt**, 125, 126.

Battle of Novi.—**Cercle**, December 5, 12.

Siege of Barcelona, 1713-1714.—**A. Belge**, September-October.

Battle of Foksani and Martinestie, and the war 1789.—**Organ**, lxvii, 4.

Campaign in China, May-September, 1900.—**R. Univ.**, November, December.

Military operations in Angoche.—**Club Mil. Nav.**, September.

Observations on the war in South Africa.—**Jour. R. U. S. I.**, December.

Recruitment in the Imperial Order of Knights in the 18th century.—**Beiheft zum M. W.**, 10, 1903.

Intercession of Emperor Karl VI. in favor of the Crown Prince Frederick of Prussia.—**Organ**, lxvii, 3, 1903.

The Germans in Corsica, 1731-1722.—**Cercle**, October 17, 24, 31; November 7, 14.

Report of the commission on the selection and transport of war material from the Philippines.—**M. de Art.**, September, October, November.

Defense of the Straits of Magellan,—an interesting historical document.—**Boletin**, August.

The 200th anniversary of the battle of Speyer.—**Wochenblatt**, 128, 129, 130.

Results of the experiences of the winter campaigns of 1870-71 and 1877-78.—**Wochenblatt**, 133.

Origin of the French cavalry.—**R. Cav.**, November.

History of the artillery, Italy.—**R. Univ.**, November; Germany, December.

Blucher's entrance in the Prussian service.—**Beiheft zum M. W.**, 11, 1903.

Journey through upper Italy with especial reference to study of its military history.—**Beiheft zum M. W.**, 11, 1903.

The war in the Caucasus.—**Sbornik**, October.

Extract from the history of the war between France and Austria.—**Sbornik**, October.

Story of a soldier's life, Wolseley.—**A. & N. Jour.**, December 26.

The study of military history.—**U. Serv. Mag.**, November.

Journal of Lt. R: Parker, 2nd Continental Artillery.—**Penn. Mag.**, January.

Military situation on the Pacific.—**Sbornik**, October.

Revolution on the Isthmus.—**A. & N. Jour.**, November 7.

Progress among the Moros.—**R. of Rev.**, December.

Work of our navy at Panama.—**A. & N. Jour.**, November 28.

Log of H. M. S. Minotaur at the Nile.—**U. Serv. Mag.**, December.

The Turks in the Channel.—**U. Serv. Mag.**, December.

History of our squadrons of evolution.—**A. Marine**, December 6.

The blockade of Brest, 1803-1805.—**R. Maritime**, November.

Role of the navy during the war of 1877-78.—**Sbornik**, October.

Sea-power in relation to land campaigns.—**R. de Mar.**, November.

MILITARY SCHOOLS.

The development of military schools in France.—**Wochenblatt**, 116, 1903.

Entrance examinations, military school, Belgium (questions in mathematics).—**Belgique M.**, November 22.

Results of entrance examinations, Russian general staff academy, and promotion higher to classes, 1903.—**Wochenblatt**, 132.

Service and instruction regulations for the military technical academy, Berlin.—**Wochenblatt**, 134.

School of Submarine Defense.—**A. & N. Jour.**, December 26.

Report on Army War College, U. S.—**A. & N. Jour.**, November 28; **A. & N. Reg.**, November 28.

School of equitation, Fort Riley.—**A. & N. Jour.**, January 16.

Naval cadets and engineers.—**R. de Mar.**, November.

School of naval engineers, Chili.—**R. de Mar.**, October.

ORGANIZATION AND ADMINISTRATION.

Naval raids and home defense.—**U. Serv. Mag.**, November.

Urgent problems of defense, U. S.—**A. & N. Jour.**, November 28.

Report of the Chief of Artillery, U. S.—**A. & N. Jour.**, November 28; **A. & N. Reg.**, November 28.

Defense of our naval fortresses.—**U. S. Mag.**, December.

Future of coast defense.—**U. Serv. Mag.**, December.

Allotment of the regular combatants units of the home establishment to their duties in war, and stations in peace.—**Jour. R. U. S. I.** December.

What are the requirements of our position artillery to repulse successfully an enemy entering our land in case of war; does its present organization and armament suffice, or what changes are necessary?—**S. M. Blaetter,** September-October.

Importance of the heavy artillery of the field army from the point of view of field and fortress warfare.—**Int. Rev.** Supplement, 55, 1903.

Dragomiroff's opinions on the importance of field mortar batteries.—**Wochenblatt,** 128, 1903.

Russia: the general staff.—**U. Serv. Mag.**, November.

Report of the Chief of Staff, U. S.—**A. & N. Reg.**, November 21.

The army staff corps, U. S.—**A. & N. Reg.**, November 28.

Important consolidation, U. S.—**A. & N. Reg.**, January 16.

Proposed reform in military organizations, Canada.—**Can. Gaz.**, December 8.

Military and naval notes on organization, changes, etc., in the armies of the principal powers.—**Int. Rev.**, October, November, December.

Lord Wolseley on the English military system.—**U. S. Gaz.**, December 5.

Problems for the British land forces and the organization of a British Imperial army.—**Wochenblatt,** 109, 1903.

Recruiting and organization of the Russian army in war and peace.—**Wochenblatt,** 111.

Reorganization of the English Army.—**Wochenblatt.** 112.

The new formation of the Russian administration and commands in Eastern Asia, according to the latest information.—**Wochenblatt,** 121.

Report on the French war budget.—**Cercle,** November 7.

Reorganization of the Russian general staff.—**R. M. Etrang.**, November.

Provisional organization of the Spanish Army.—**R. M. Etrang.**, November.

Scheme for a corps of native mounted scouts.—**Jour U. S. India,** October.

Notes on a reorganization scheme for native infantry.—**Jour. U. S. I. India,** October.

Organization of military engineers and engineer troops.—**Sbornik,** October.

Preliminaries of the organization of 1806.—**R. Mil. Portugal,** August 15, October 15, November 30, December 15.

The general staff, U. S.—**U. Serv.**, January.

The German army at the close of 1903.—**R. M. Etrang.**, December.

Organization of the Brazilian army.—**R. Mil. Brazil,** October.

The modern Japanese soldier.—**S. M. Blaetter,** September-October.

The Turkish soldier.—**S. M. Blaetter,** September-October.

The non-commissioned officer.—**Cercle,** October 17, 24, 31; November 7.

Army of Peru and the French mission (officers sent as organizers, etc.).—**A. Marine,** December 6.

Growth of the military power of Japan.—**Jour. U. S. I. India,** October.

Military power of Japan.—**U. S. Gaz.**, December 26.

The English army.—**Cientifico,** October 15; November 1.

The Sengalese tirailleur.—**Cercle**, November 14, 21.

Empire of India and its army.—**Cercle**, November 5, 12, 19, 26.

The Chinese army.—**Jour. R. U. S. I.**, November, December.

The Roumanian army.—**A. Marine**, December 27.

Military organization of Spain.—**Exercito**, November.

Recruiting the army, U. S.—**A. & N. Jour.**, December 26.

The recruiting question, England.—**U. Serv. Mag.**, November.

Promotion and examination of army officers.—**U. Serv. Mag.**, November.

England's military problem.—**A. & N. Jour.**, January 2.

Promotion by selection.—**A. & N. Reg.**, December 56; January 16.

The training of the English officer.—**Ueberall**, 49, 1903.

The corps of officers.—**U. Serv. Mag.**, December.

Promotion of regimental officers.—**U. Serv. Mag.**, December.

How best to promote rifle practice among our countrymen in time of peace as a preparation for war.—**Jour. M. S. I.**, January-February.

Training of the organized militia.—**Jour. M. S. I.**, January-February.

Future of the volunteers. Some facts and suggestions.—**U. Serv. Mag.**, January.

Military railway and telegraph services of the principal European armies.—**S. M. Blaetter**, September-October, December.

The South-African campaign: report of the war commission.—**Cercle**, October 17, 24.

Reorganization of the colonial troops, France.—**Cercle**, October 17.

Recruitment of officers for Mozambique.—**R. Mil. Portugal**, August 15.

Feeding armies in times of war.—**Int. Rev.** Supplement, 55, 1903.

Tactics, horse-breeding and remount service.—**Wochenblatt**, 114.

The supply troops of the German army (transport, subsistence, etc.).—**Ueberall**, 50, 1903.

Remounts.—**Belgique M.**, November 15, 22; December 6, 13, 20, 27.

Transport and supply.—**U. Serv. Mag.**, December, January.

French railways under German military management, 1870-71.—**Wochenblatt**, 123, 1903.

Germany's horse-breeding from a military point of view.—**Wochenblatt**, 133.

Transport and supply services of the international troops during the Chinese disturbances, 1900-01.—**Int. Rev. Beiheft** 45, 1903.

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Food supply in time of war.—**U. S. Gaz.**, November 21.

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Disposal of the wounded of cavalry.—**Jour. U. S. I. India**, October.

Object of the problems of military hygiene.—**Sbornik**, October.

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The frontier barrier of the Alps considered from an Italian and French point of view.—**Int. Rev. Beiheft**, 44, 1903.

Leading armies in time of war.—**Int. Rev.** Suplmt., 55, 1903.

Results of battle.—**Wochenblatt**, 109, 1903.

Verdy du Vernois' strategical studies.—**Wochenblatt**, 110.

Evolution of modern strategy.—**U. Serv. Mag.**, November, December, January.

Strategy of the Paardeburg campaign.—**U. Serv. Mag.**, December.

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Notes on leading combined cavalry detachments, considered with reference to Swiss conditions.—**A. S. M. Zeit. Beilage**, 3, 1903.

The new infantry attack.—**S. M. Blaetter**, September-October.

On the question of the infantry attack.—**Wochenblatt**, 132.

Flanking infantry fire.—**Kriegstech**, 9, 1903.

Tactical problems.—**Belgique M.**, October 11, November 8, 15; **Cercle**, October 24, November 28.

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Warfare of the future.—**A. & N. Jour.,** January 16.

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Development of the submarine in the direction of increased scope; study of the Lake submarine boat Protector.—**Jour. A. S. N. E.,** November; **Scien. Amer.,** December 16.

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Success of British submarines.—**Can. Gaz.,** December 22.

Torpedoes and submarines.—**A. & N. Gaz.,** November 28.

Torpedoes.—**R. Marit. Brazil,** September & October.

Reports on torpedo boats, (cruising qualities).—**A. & N. Reg.,** January 16.

Re-arming of the U. S. battleships with torpedo tubes.—**Rundschau,** December.

The new battle ships for the Imperial navy of the Erzherzog-Karl type.—**Seewesens,** November.

The firing at the Suffren.—**Ueberall,** 49, 1903.

The eternal struggle: guns and armor (test of the Suffren's turret.)—**M. de Art.,** September.

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A French opinion on the German fleet.—**Ueberall,** 50, 1903.

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Naval scouts for the fleet.—**Yacht**, November 7.
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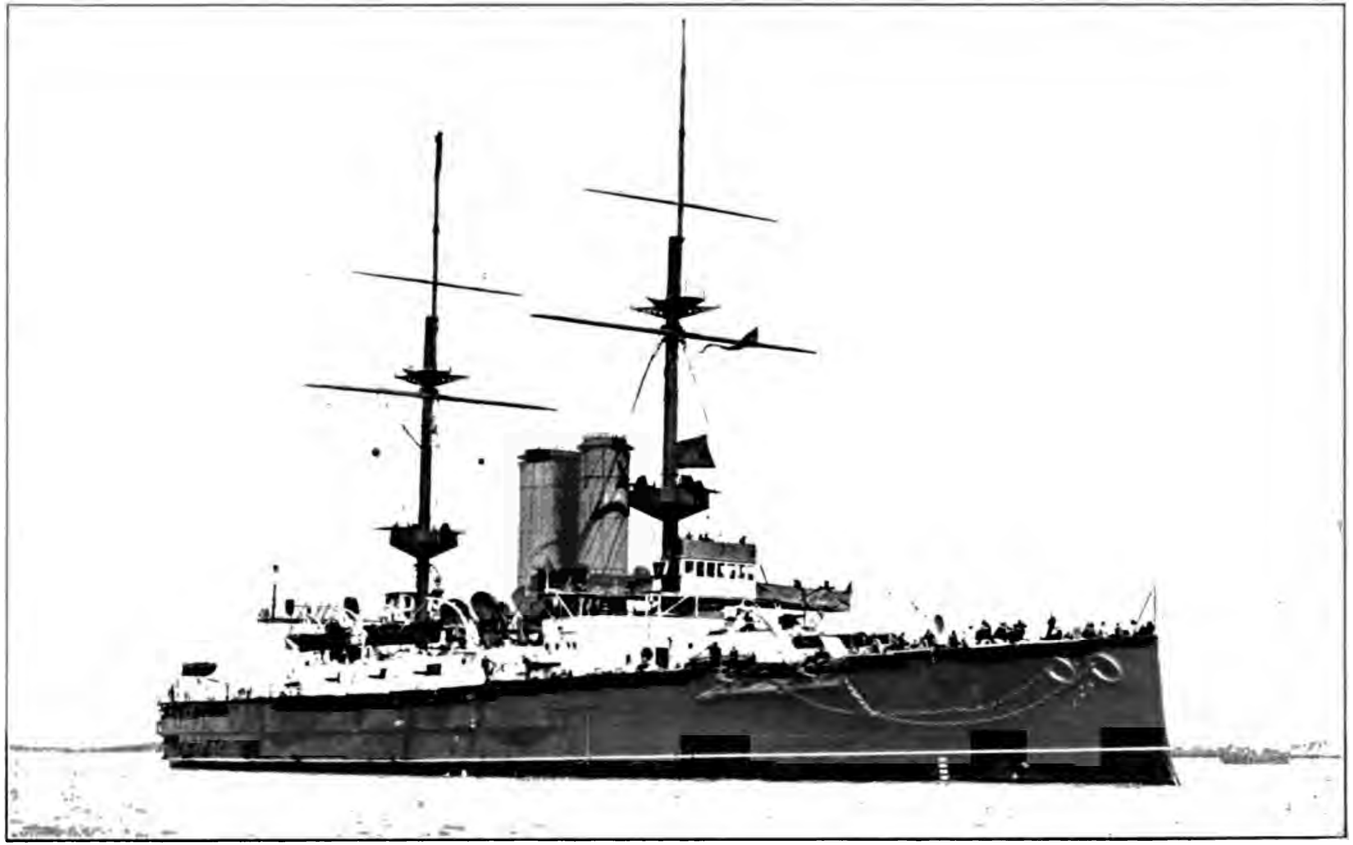

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THE "GRUBB" SIGHT.*

INTRODUCTORY REMARKS.

The "Grubb" Collimating Telescope Gunsight is essentially different from any existing sight and embodies the introduction of a totally new principle in the construction of gun sights.

By a simple optical contrivance a "virtual" or "ghost" image of a cross (+) or other device is made to be seen as if projected upon the object aimed at, so that to aim correctly it is only necessary to direct the weapon so that the cross (+) shall appear superimposed on the object or the part of that object. The cross (+) and the object aimed at being virtually at the same distance, both are seen distinctly at the same time.

No back sight is required, although the "Grubb" sight may be fitted in conjunction with existing sights where a back sight is required, without interfering with it.

It can thus be attached to a rifle without interfering with the ordinary rifle sights.

It is also applicable to all varieties of guns from rifles to the largest types of ordnance.

By means of a simple electrical attachment the cross (+) can be most conveniently illuminated at night or at dusk, when excellent practice can be made on any object which is sufficiently visible for its direction to be determined.

---

* We are indebted to Mr. H. C. Sheridan, of Messrs. Vickers Sons & Maxim, Ltd., for the description and accompanying illustrations of this sight.—ED.

It is not in itself necessarily a telescopic sight, but any desired magnifying power can be used with it.

Unlike telescopic sights, the field of view when using the "Grubb" sight is practically unlimited.

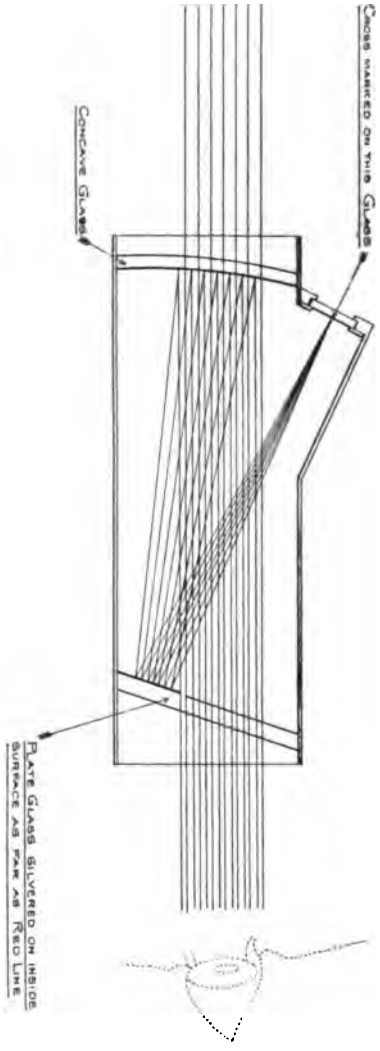

Concave Glass
Cross marked on this Glass
Plate Glass silvered on inside surface as far as Red Line

Fig. 2.

It is water tight and air tight.

A few hours instruction is sufficient to teach the merest tyro to aim correctly.

DESCRIPTION OF PRINCIPAL FEATURES AND ADVANTAGES OF THE "GRUBB" SIGHT.

The external appearance of the "Grubb" sight as fitted to a rifle is shown in fig. 1, and a longitudinal section in fig. 2, which also shows diagrammatically the course of the rays of light.

It consists as will be seen of a short metallic tube which is generally of rectangular section.

The rear end of this tube (that next the observer's eye) is closed by a window of parallel plate glass, the lower portion of which is silvered on the inside face, the upper being left transparent.

The front end (that farthest from the observer's eye) is closed by a piece of glass which is ground and polished to a convex curve on the outside and a concave curve on the inside, the radius of curvature being practically the same on each side. The concave surface of this window is coated with a semi-transparent and highly reflective film chemically deposited. It will be seen also that this window is slightly tilted.

At the top is formed a projection or hood in which is inserted a diaphragm generally made of glass coated with some opaque coating, on which is cut the cross (+) or device which it is desired to see projected on the distant object.

The rays from the object are represented in fig. 2 by the continuous lines: emanating from a distant object they are practically parallel, and as both front and back windows have each parallel surfaces these rays suffer no sensible alteration in their course and enter the eye exactly as they would do if the sight were removed.

The rays which enter the eye to form the image of the (+) diverge from the cross (+) (which may be considered as a luminous object), and are reflected (still diverging) from the silvered portion of the back window on to the concave surface of the front window, which is coated as described with the reflective film referred to above, and thence through the upper part of the back window to the observer's eye. The inside surface of the front window is of such a concavity that it parallelizes the formerly divergent rays, and causes them to enter the eye as parallel rays, or in effect, as if they had emanated from a large cross on the distant object itself instead of from a small cross close to the observer's eye, consequently there is no "parallax"," a fact easily tested by any one by moving the eye backwards and forwards, or up and down, on looking through the sight; such movement will be found to produce no effect on the coincidence between, or superposition of, the cross (+) and the object; in fact, to quote from an article in "Engineering" "it is like a fore sight carried on the end of a pole attached to the barrel." "Evidently, if the barrel could be so far extended that the marksman could place his fore sight on the chest of his enemy there would be no need of a back sight at all, and that is exactly what is done by this sight''.

The fixity of the eye of the observer not being necessary there is no necessity for a back sight—a very important advantage in itself, more particularly when firing in a constrained position as is often necessary in warfare.

That this virtual or ghost image of the cross (+) is really formed at or near the plane of the object aimed at, is proved by the two photographs reproductions of which are here shown, see fig. 3 and fig. 4.

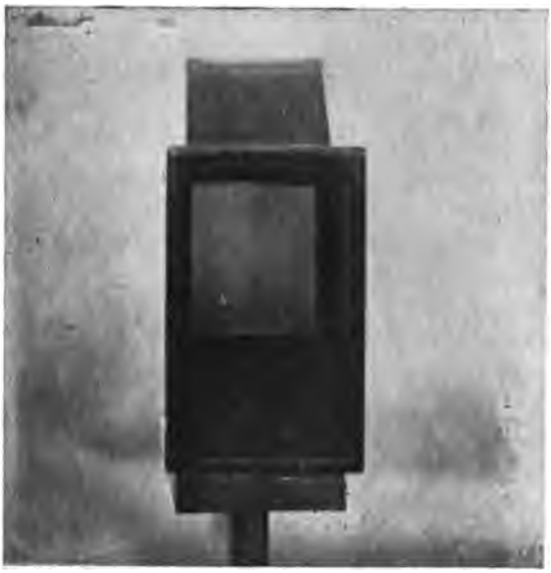


Fig. 3.

The first of these, fig. 3, is a photograph taken of a large pattern of the "Grubb" sight, obtained by placing the camera a few feet behind the sight, focussing on the framework of the sight and exposing a plate.

It will be seen in this case that the sight body itself is quite distinct, but the distant view is so indistinct that it can hardly be seen, and also that the cross (+) is equally out of focus.

Fig. 4 was taken without altering the position of the camera, but the focussing was altered so as to bring the distant view sharp.

It will be seen that in this case the body of the sight is quite indistinct, but the distant view and the cross (+) are both quite distinct, showing that this "ghost" image of the cross (+) is practically in the plane of the distant object.

In looking through the sight the object aimed at is seen as distinctly as with any open sight except for the very slight loss of light due to the rays having to pass through the semi-transparent film before referred to.

Much of the difficulty of the tyro marksman depends upon the impossibility of seeing distinctly the ordinary foresight of the rifle (which is about 30 inches from the eye) at the same time as the distant object, and this difficulty is also very patent in the case of even experienced marksmen, and more particularly felt by those of mature age.

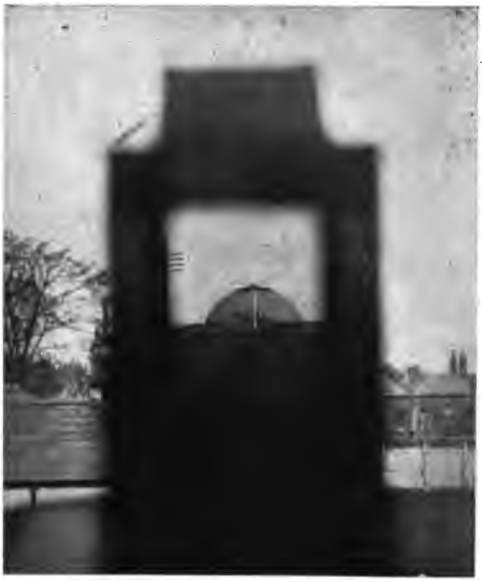


Fig. 4.

Now, in the case of the "Grubb" sight, as the rays which go to form the image of the cross (+) on the retina are parallelized before they reach the eye, they enter under similar conditions to those which simultaneously enter the eye to form the image of the object, and therefore both object and sight *are seen absolutely distinctly at one and the same time.*

Although, in itself this sight is not a telescopic sight, telescopic or magnifying power can be applied to it if desired, and without many of the disadvantages of the ordinary telescopic sights.

Just as it is possible to focus both object and cross (+) on a photographic plate, so also is it possible to focus both in a field glass or telescope, and the larger patterns of this sight (used for field and naval guns and guns of position) are all supplied with attachments for monoculars or binoculars. The telescope, however, in this case, is used simply as a means of magnification of both object and cross (+) and any error of adjustment or looseness in the lenses, or want of fit in any part in no way affects the accuracy of the sighting because it affects both the object and the cross (+). In this respect, also, it has considerable advantages over the ordinary telescopic sight, in which accuracy and constancy of adjustment is very essential.

The necessity for the addition of telescopic power, moreover, to the "Grubb" sight, does not occur in as many cases as with the ordinary sights.

Before the introduction of the "Grubb" sight comparisons between telescopic sights and open sights showed a marked superiority in the former, and this superiority was generally attributed to the magnifying property of the telescopic sights, but the fact was lost sight of that there were other important differences between the open sights and the telescopic sights besides the magnification.

In the old form of telescopic sight the marksman has two perfectly distinct objects to bring into coincidence, viz: His target and the cross lines of his telescope, and a little shift of his eye at the eye stop of his telescope does not affect the accuracy of the superposition of these, while in the open sights he has to try and match one distinct object (his target) on an indistinct object (his foresight) and the slightest variation of his eye from the centre of his backsight is fatal.

No wonder then that the telescopic sights are found superior to the open sights.

In the "Grubb" sight, however, these two conditions, viz: (the having of two distinct objects to superpose and the absence of necessity for fixity of observer's eye) are present whether magnifying power is used or not. Therefore, it is that telescopic magnifying power need not be used with the "Grubb" sight unless the object be very small and distant and for this or for other causes it is necessary to magnify it.

The advantages of being able to dispense with a telescope and yet to insure as accurate sighting as with it, are numerous, the most obvious being the freedom from the necessity of keeping the eye close to an eye stop and thus shutting out all view except the few degrees seen through the telescope.

On a rifle, the eye is generally placed about 5 inches in rear of the sight.

In the case of larger guns the eye can be placed in any position that at the moment may be found convenient.

It follows from this that the attention of the marksman need not be restricted to the field of view seen through the sight as he can see all round it as well; in fact, he can see practically as much of the horizon as with open sights, and a considerable amount of latitude for the position of the eye is allowed without impairing in the slightest degree the accuracy of the sighting.

The "Grubb" sight can be made of any size according to the weapon to which it is to be attached.

The present patterns are three in number, the smallest being suitable for rifles, sporting or service patterns, Maxim guns and such small ordnance.

The rifle sight measures 1 inch by .7 inches by 3 inches, and weighs about 3 ounces.

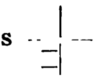
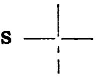
The second is of a size suitable for 10-pounder to 20-pounder field guns and small naval guns.

It measures 1.15 inches by 2 inches by 6.25 inches, and weighs 2 pounds 2 ounces.

The third is suitable for all guns larger than the above and measures 2.5 inches by 1.5 inches by 6.85 inches, and weighs about 3 pounds.

The attachments can be made suitable for all guns.

In sporting rifles it is preferably attached without any elevating arrangement, but it may be supplied with diaphragms of special pattern.

It is useful, for instance, in some cases, to make the diaphragm with extra marks thus  or interruptions in the line forming the lower portion of the cross thus  in order that allowance can be made for elevation at long ranges without any adjustable supports.

It follows, also, from the above, that the teaching of the use of the weapon is rendered very much simpler, as all that is necessary is to see that the object aimed at is in the centre of the + at the moment of firing. As a consequence also the skill required for the use of the "Grubb" sight is much less than that required in either the old form of sights or the telescopic sight, and practically it will be found that it supplies the means of placing the indifferent marksman on a level with the best and that with much less practice.

The same remarks apply to the sights on the larger guns, but here the facility of readily applying telescopic aid when necessary adds to the efficiency of the sight.

Even when not using a telescope attached to the sight, or if the former be lost or not available, the officer in charge of the gun can always use his binocular with these sights, viewing the object through the sight with one element of his binocular, the other element viewing the object without the sight. In this way a most satisfactory view of object and cross (+) can be obtained.

APPLICATION OF THE "GRUBB" SIGHT.

The following are a few illustrations of the various applications of the "Grubb" sight:

Fig. 1 shows the "Grubb" sight fitted to a .303 service rifle.

The sight is fitted on a bracket which slips into a socket fixed on the left hand side of the rifle. The sight is adjusted for the various ranges by turning a small disc on top of the sight. This disc is connected with a screw, the threads of which engage with corresponding teeth on a segment fixed to the sight bracket. The underside of the disc has a spiral groove which engages with a stud on the range indicator, so that by turning the disc the indicator is moved longitudinally. The top face of the disc is graduated for the various ranges, the graduation being arranged on a spiral line corresponding with the spiral groove on the underside of the disc.

There is also another method of applying the sight which does not interfere at all with the ordinary sights, the sight being mounted to slide on the face of an arc on the left hand side of a rifle, and in a convenient position for the eye. The top of this arc is notched, and the notches are cut to correspond with given ranges, which ranges are engraved on the arc. A small and neat spring catch retains the sight at any of the notches, and adjustment of range is effected by sliding the sight along the arc.

Fig. 5 shows the "Grubb" sight with a similar arrangement on a Mauser rifle.

Figs. 6 and 7 show the "Grubb" sight adapted for use with a 6-pdr., Q.F. naval mounting. In this case the bracket for the sight is constructed so as to fit on the mounting after the removal of the ordinary tangent sight, and without any alteration to the mounting. The "Grubb" sight is mounted on the top of a radial rack securely held by, and capable of sliding in, a socket formed in the sight bracket. Elevation of the sight rack is

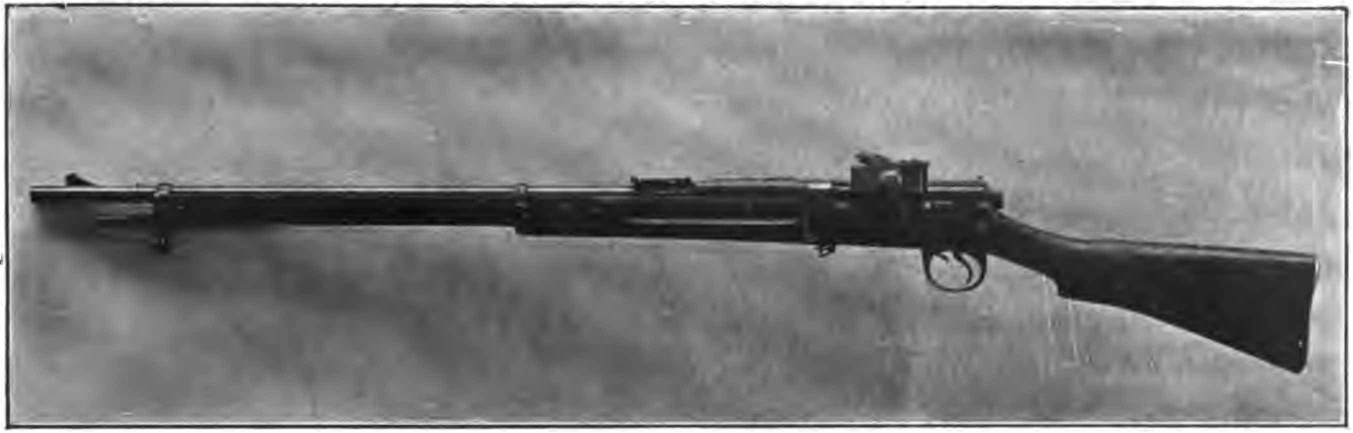


Fig. 1.

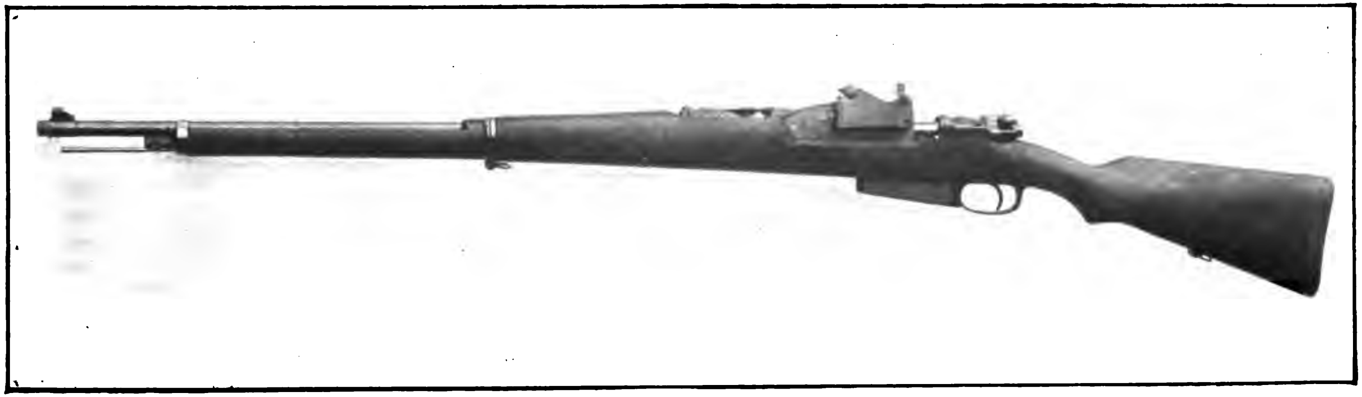


Fig. 5.

effected by a worm wheel and pinion gear. Deflection of the sight is arranged for, and consists in training the sight round a centre by milled head and screw in the usual manner.

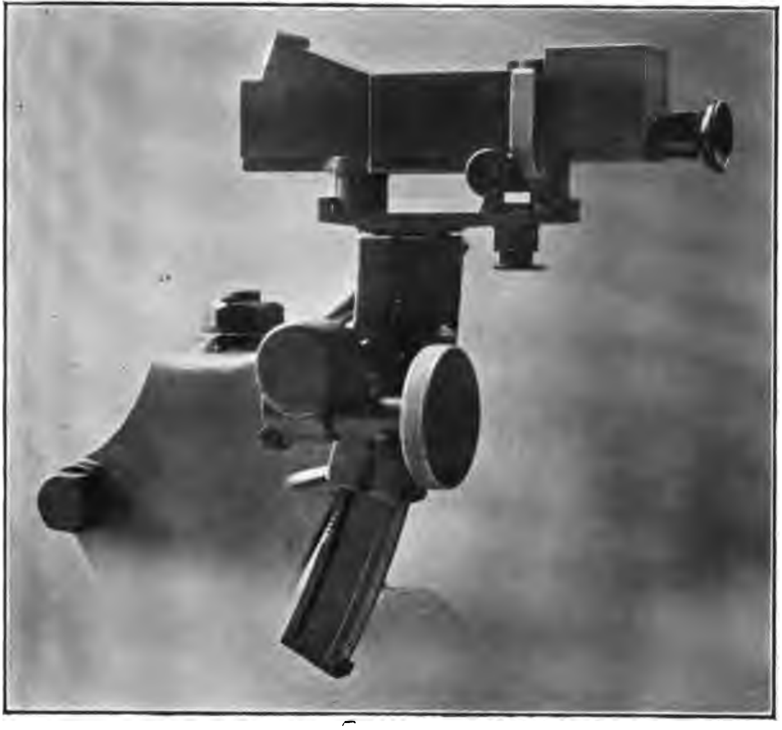


Fig. 6.

Fig. 8 shows the "Grubb" sight fitted in conjunction with a bar sight of a 6-inch Q.F. mounting, the "Grubb" sight being carried on an extension of the ordinary sight bar, so that it is to the rear and slightly above the ordinary back sight. By this arrangement the "Grubb" sight can be used without interfering with the ordinary sights. When desired the extension piece may be arranged so that the "Grubb" sight is capable of being retained at any desired position longitudinally, so that the eye piece may be adjusted to any convenient position to suit the gunner. The "Grubb" sight may be readily and easily withdrawn from the extension, as it is held by a small "push" catch. After removal of the "Grubb" sight the ordinary sights may be used.

Fig. 9 shows the sights after removal of the "Grubb" sight.

Fig. 10 shows the "Grubb" sight in position with a small electric lamp fitted to the front for illuminating the cross for use at night time.

Fig. 11 shows the "Grubb" sight applied applied to a bar sight for 12-pdr. Q.F. mounting. In this case it is carried above the ordinary back sight, and may be easily and quickly removed, as it is held by a bayonet joint arrangement, and a small spring catch. It does not in any way interfere with the ordinary sight, and, as before stated, it may be removed in an instant, and the ordinary sight reverted to if desired.

Fig. 12 shows the ordinary sight after removal of the "Grubb" sight.

Fig. 13 shows the "Grubb" sight in position with the electric lamp for illuminating the cross (+) for use as a night sight.

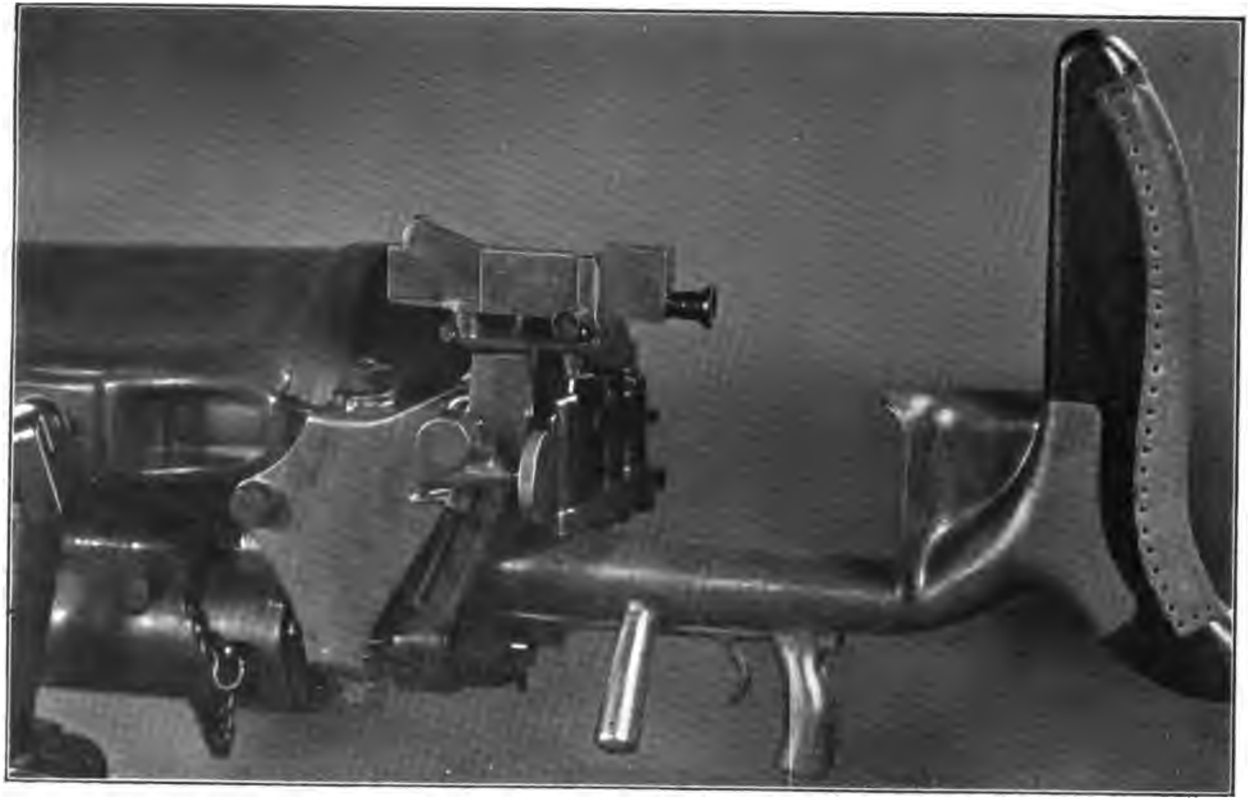


Fig. 7.

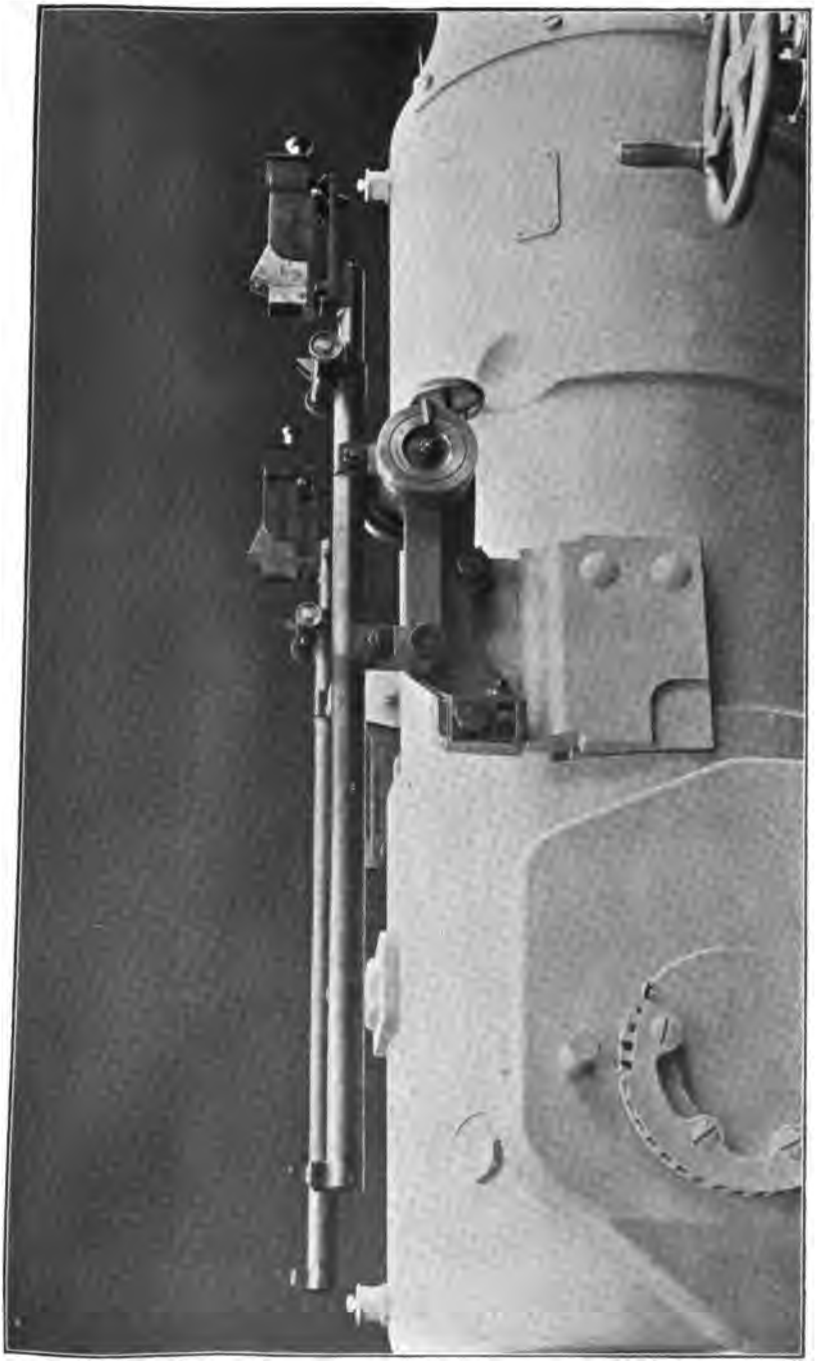


Fig. 8.

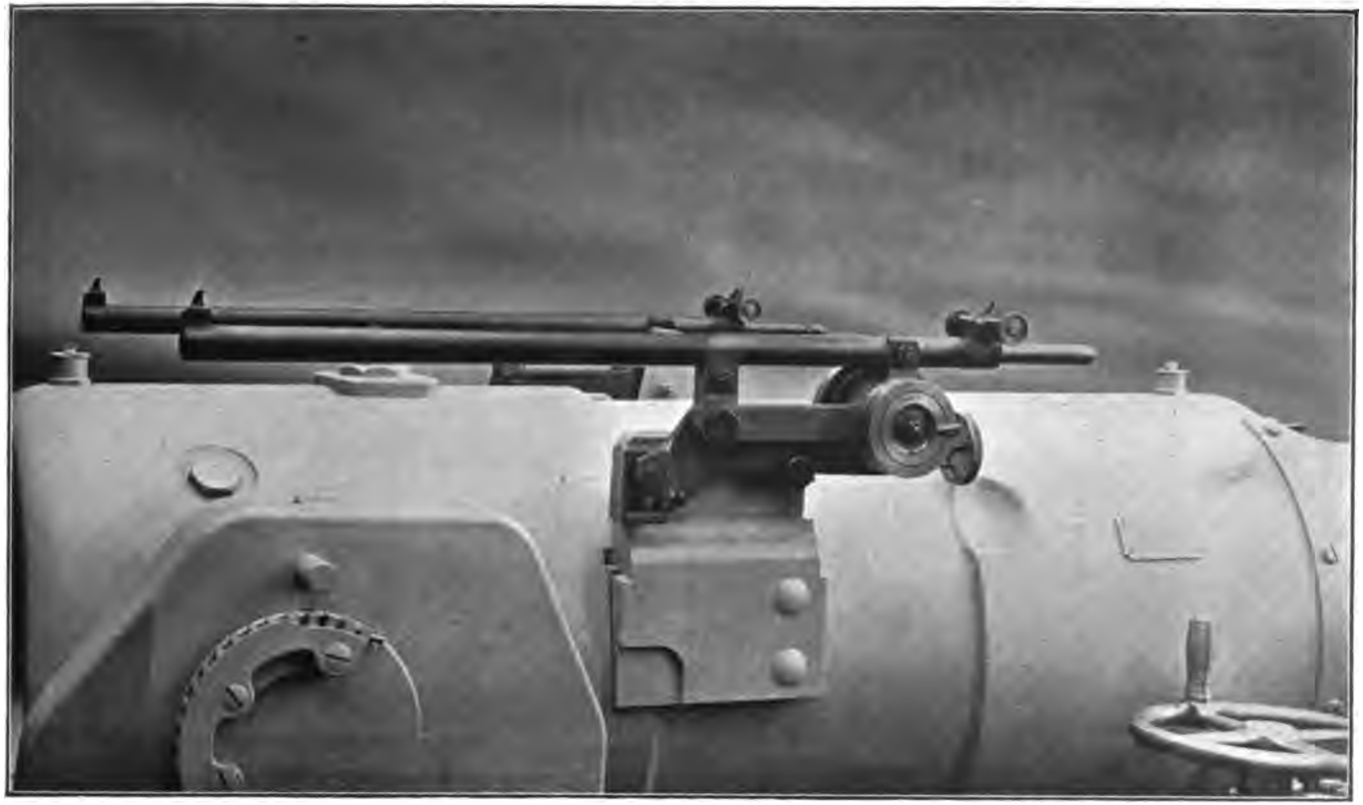


Fig. 9.

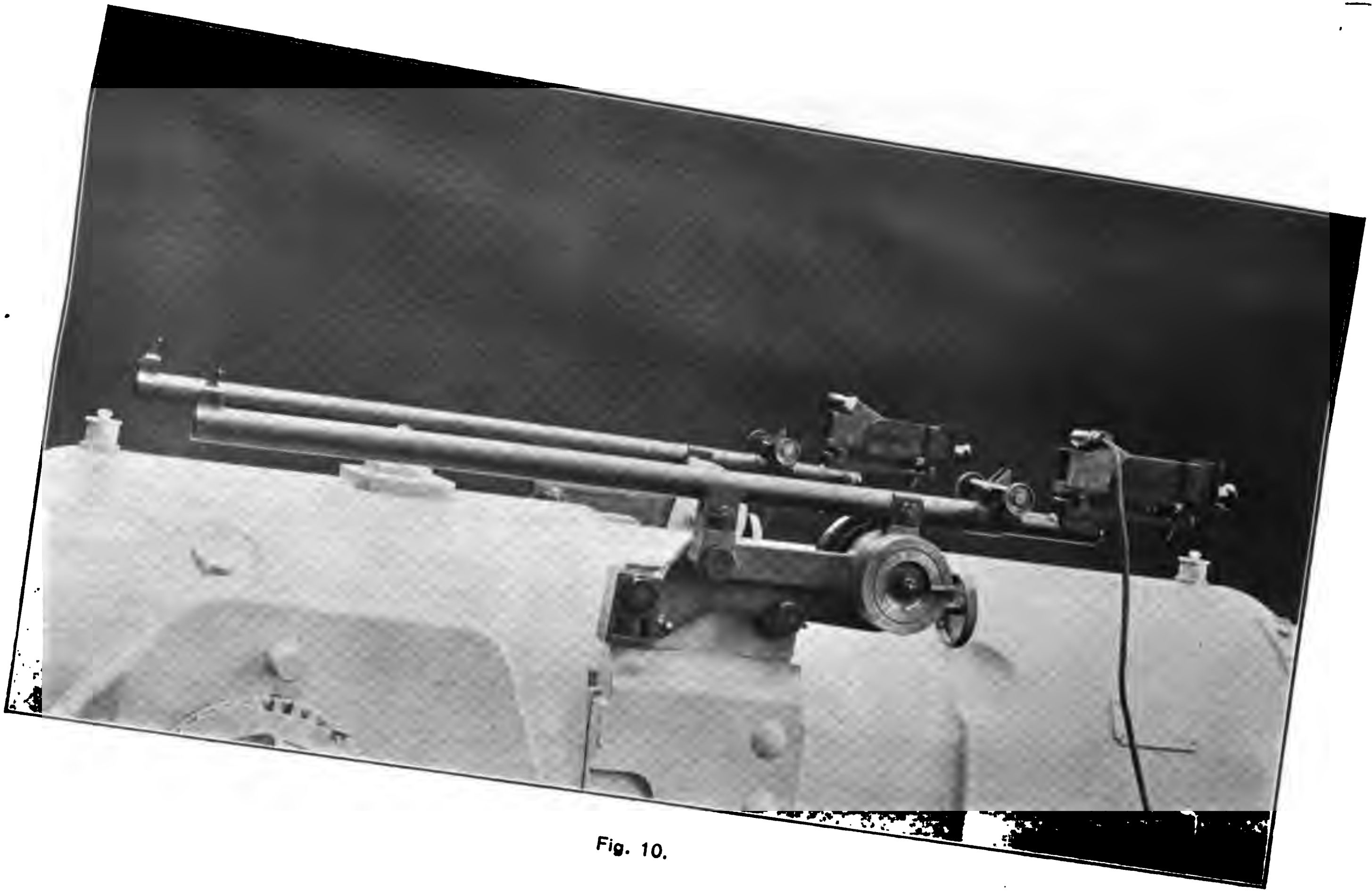


Fig. 10.

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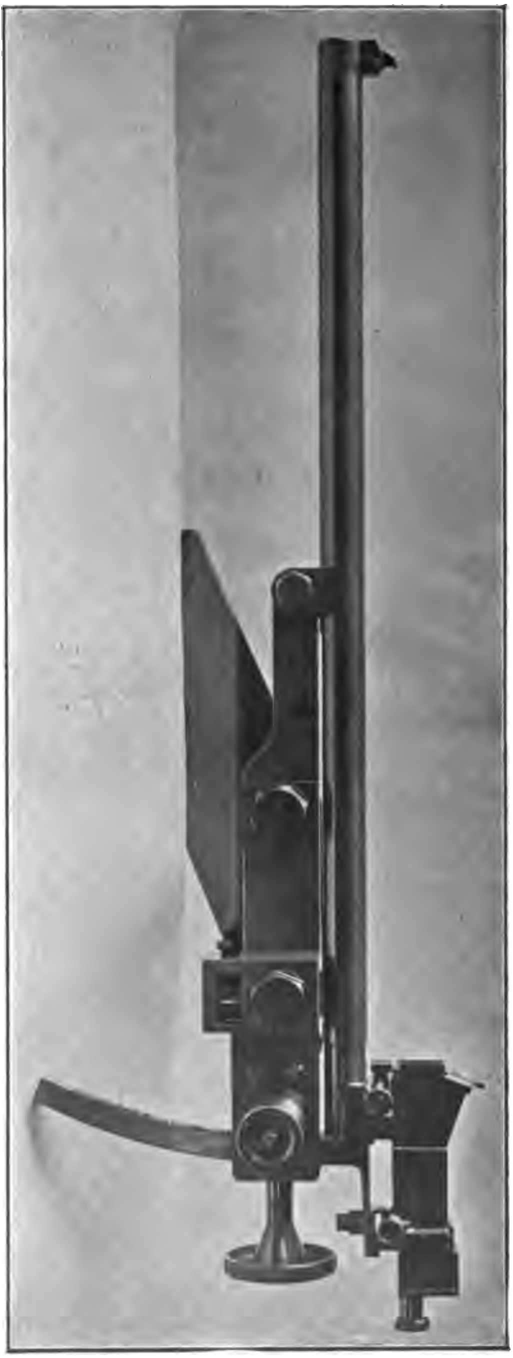


Fig 11.

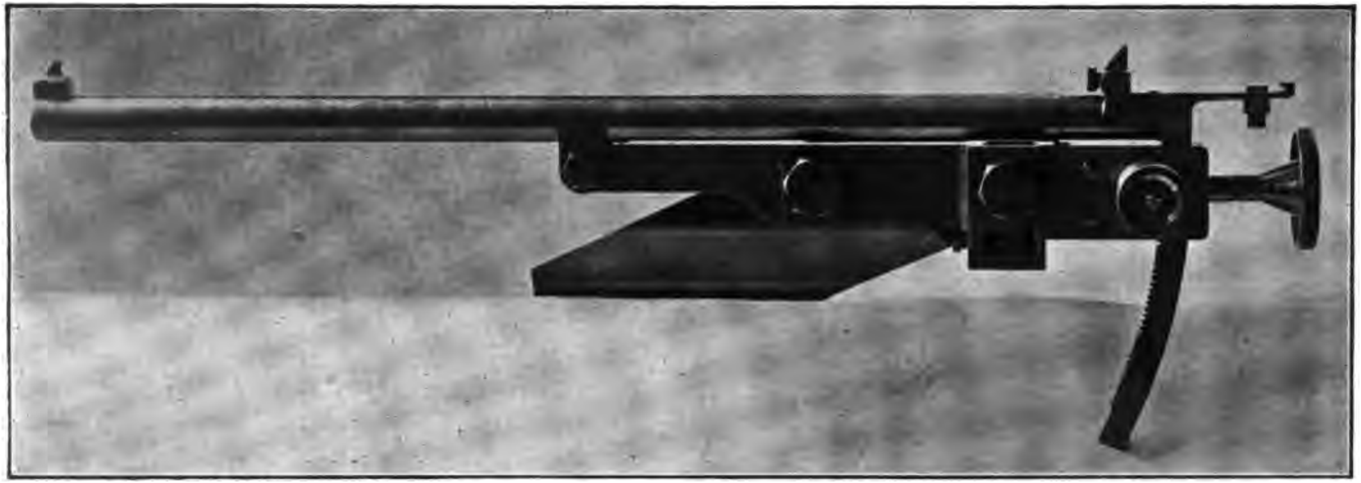


Fig. 12.

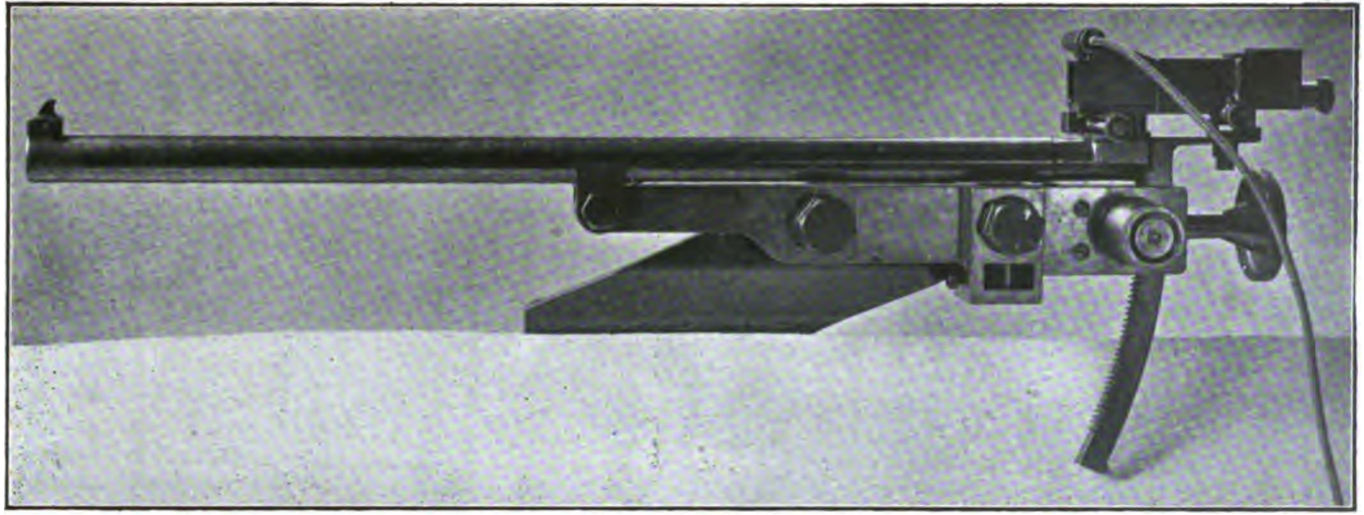


Fig 13.

THE GUNNER'S CORRECTOR AND IMPROVED DEFLECTION SCALE.

By Captain E. W. HUBBARD, Artillery Corps.

The devices described below are the outcome of an attempt to solve certain practical problems in gunnery in such a manner as to eliminate calculation and at the same time give the utmost speed and accuracy under service conditions.

The gunner's corrector is adapted to give, by simple inspection, corrections depending on the azimuth of a point, or on azimuth and range combined. It may therefore be used to give corrections for wind or range and azimuth differences, etc. This is done automatically, continuously, and without interference with the usual methods of plotting or serving the gun. In fact these operations are utilized to give the corrections.

Getting the total deflection due to wind, drift and angular motion of the target, or "travel", has heretofore been a complicated and very unsatisfactory operation; similarly for range corrections due to wind. Not only was careful instruction and drill necessary but even with well instructed men the operations were still of such a character and required such a number of operators that accurate results could scarcely be hoped for in rapid work. This trouble is largely due to the necessity of first getting wind components which are constantly changing, and also to the necessity of taking data off one board and applying it to another device before the result can be announced. The present difference chart is for this and other reasons an unsatisfactory piece of apparatus.

It is therefore essential that one fundamental piece of apparatus, as the plotting board or gun itself, shall by its own operation give all possible corrections. This idea is carried out in the corrector as will be seen and we thereby avoid the various errors resulting from multiplicity of apparatus, scales, tables, etc.

No matter how carefully the total deflection is obtained, all is wasted if it is not set accurately on the sight. This involves the design of the sight and deflection scale which are therefore considered herein as part of a system.

THE WIND SYSTEM.

In the corrector the simple system of wind shown in figure 1 is used, in which the angle between the wind and plane of fire is indicated by degrees from 0 to 90 in quadrants numbered both ways from the plane of fire. For all winds to the right of the plane of fire, quadrants 1 and 2, the deflections are positive,

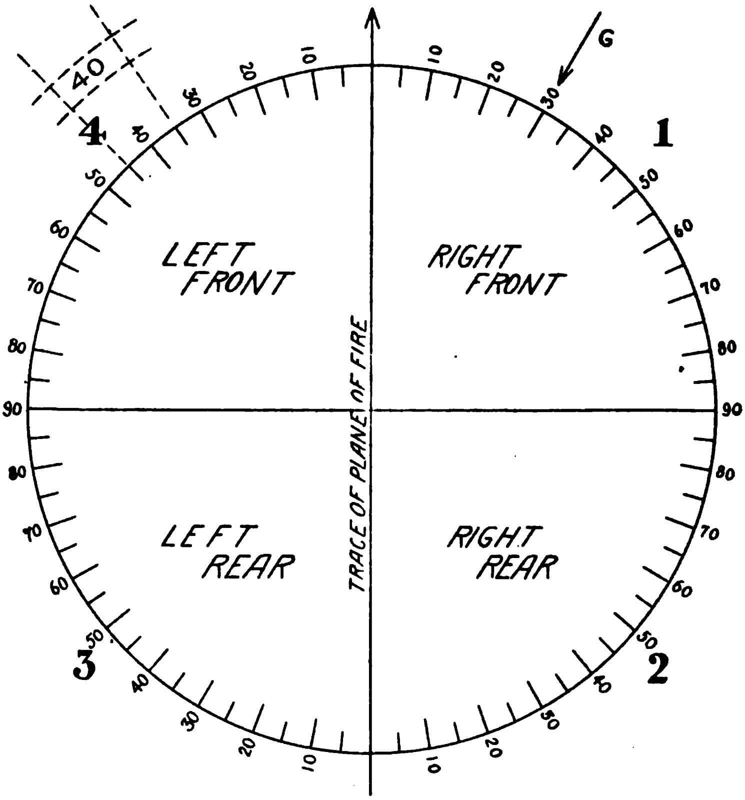


FIGURE 1

and for quadrants 3 and 4 negative. For quadrants 2 and 3 the range corrections are negative, and for quadrants 1 and 4 positive. A wind as shown by arrow G would be called a "right front wind of 30 degrees" and would evidently have the same deviating effect as a right rear wind of 30. The range effects would be of the same value but of different signs.

This classification is simple and natural, lends itself easily to description and calculation, but is not at all necessary to the practical use of the corrector. Once set correctly the operator does not need to consider further the precise character or angle

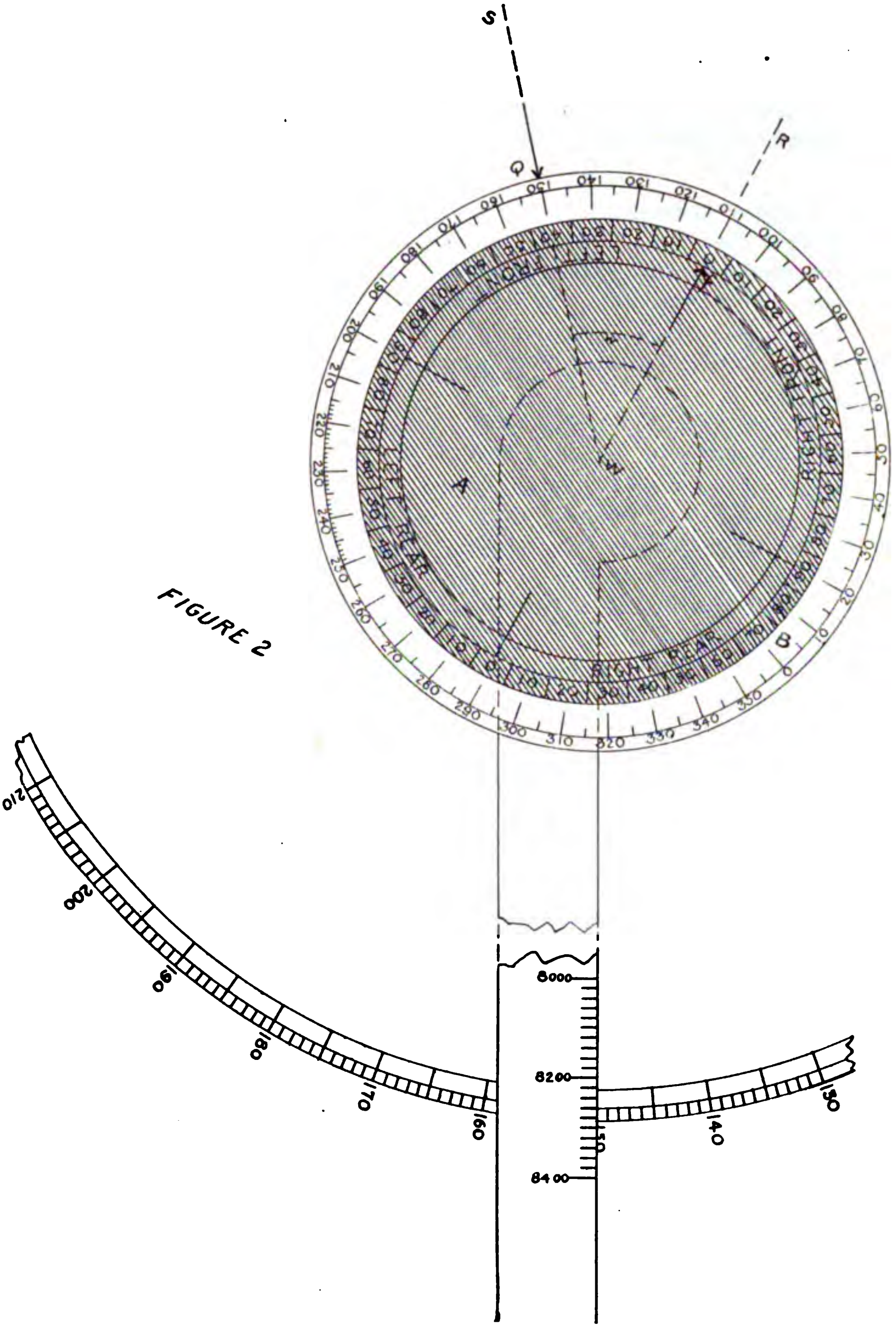

S
Q
R
A
B
LEFT FRONT
RIGHT FRONT
LEFT REAR
RIGHT REAR
8000
8200
8400
210
200
190
180
170
160
150
140
130

FIGURE 2

of the wind. By this means components are done away with in practice, as are also the terms "accelerating", "retarding", etc., thus much simplifying the instruction. The calculations are done at leisure and once for all. The operation is thus reduced to inspection of results as they appear.

PRINCIPLE OF THE CORRECTOR.

Suppose the wind circle of figure 1 to be represented by the shaded disk **A** of figure 2, turning concentrically within **B**, a reversed azimuth circle. In figure 2 the wind angles are given only every 10 degrees, the division of, say, 40 corresponding to the limits 35-45 of figure 1. The actual 40 is therefore at the center of the division. **B** is supposed to be graduated in even degrees.

Given the azimuth of the wind as 110. Turn disk **A** until the arrow f points to 110 on the outer circle. The character and angle of this wind for any plane of fire, or gun azimuth, will now be indicated opposite the corresponding number. Thus for a gun azimuth of 310, the wind is a right rear of 20 degrees, and so all around the circle.

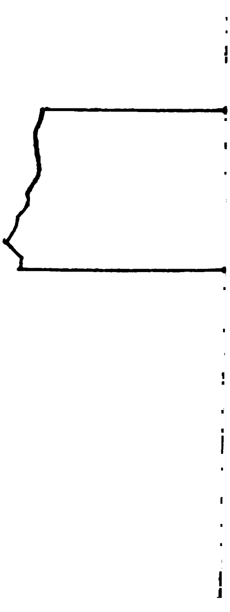
Holding **A** and **B** in the same relative position, assemble on the gun ruler as shown. Set the gun ruler to any degree azimuth, as 150. Hold the ruler and turn **A** and **B** until 150 comes to a fixed index, Q. Clamp ruler and disk together as shown. Now as ruler is turned in plotting, Q will indicate the corresponding character and angle of the wind, in this case a left front wind of 40 degrees. It is evident that the angle between the lines **WS** and **RW**, (or **RW** prolonged), is in all cases the angle between the wind and gun.

If now range circles be drawn on disk **A**, the corresponding corrections can be inserted radially and read through a window at a fixed position, Q. This with changeable disks for different wind velocities would constitute essentially the corrector in disk form.

It will be noted that Q may have any position whatever in azimuth, the condition being that it indicates the gun azimuth as shown at the ruler itself. The essential principle of the corrector is then to cause the assembled disks to turn with equal angular motion to the gun ruler or gun itself. This condition may be fulfilled in various ways giving rise to different forms of the corrector.

CYLINDRICAL FORM FOR PLOTTING BOARD.

This, shown in figure 3, has the advantage that the deflections can be separated from the range corrections. In the figure, **A**, FI



the cylinder, corresponds to the shaded disk **A** of figure 2. **B** is a cover, or cap, fitting friction tight, graduated in reversed azimuth and corresponding to the circle **B** of figure 2. The cylinder is mounted on a base, **E**, fastened to the plotting ruler, and all held and clamped by a vertical spindle and thumbscrew.

H is a base permanently fastened to the board at any convenient azimuth so as not to interfere with the plotting ruler. **L** slides on **H** and is held in place by a thumbscrew. The whole is thus quickly dismounted. **L** is cut away on the cylinder side and provided with an index corresponding to **Q** of figure 2. **C** is a sliding piece controlled by a rack and the pinion **K** and having two windows so arranged that when the index is at a certain range both windows expose the corresponding corrections. The whole thus corresponds to figure 2.

Nine cylinders are provided, one for each 5 mile wind, from 0 to 40 miles. Select a cylinder marked as nearly as possible for the actual wind velocity. Put on cap **B** and turn until index f is at the wind azimuth, (110 in figure). Set ruler to any azimuth and assemble all on the ruler. Turn assembled cylinder until the gun azimuth, (150 in figure), comes to the center line of **L** as shown by index, and clamp all together. Plotting now goes on as usual. When the range is announced set windows to the nearest five hundred yards and read corrections. The number nearest to the center of window is always taken, or if two are shown an interpolation may be made. This setting in range may be made on the last plotted position and the corrections are then read instantly as soon as set-forward point is determined.

If the wind velocity changes put on another cylinder. If its azimuth changes set f to the new azimuth, clamp and go on as before.

This vertical cylinder form is particularly adapted for use with a "shifting center" ruler, readings being made when at the gun center. The cylinder may be placed horizontally and connected to the ruler by a simple gear, or by the use of shafts placed at any position on the board.

As seen, the corrector thus passes automatically from the fundamental data of velocity and azimuth of wind to the actual units of corrections as applied and all intermediate steps are done away with. The result is great speed and accuracy. The corrector is never behind the plotting.

All calculations are done beforehand at leisure, once for all and with the utmost accuracy. In the plotting room the only calculation for deflection is adding the travel. By such means the prediction interval can be shortened.

The number of cylinders to be provided is a matter of judgment, as there is nothing to prevent them being made for each mile of wind. In above arrangement two miles would be the maximum error in selecting a cylinder, which is probably as close as wind velocities are determined at present. In the 10-inch B. L. R. a wind error of 2 miles corresponds to only 2.6 hundredths deflection at 10,000 yards for a 90 degree (cross) wind, and less for smaller ranges and angles. This amounts to a lateral error of less than 5 yards at 10,000.

At the first sight it might appear that the range interval is too large. This again is a matter of judgement, size of cylinder, etc. By a simple interpolation the corrector reads to within 500 yards, or a maximum error in range of 250. The resultant maximum error in deflection for a 20 mile wind at 8,000 yards is 1.5 hundredths. This again is only at certain angles, so that the errors are considered to be well within working limits.

Graduation of Cylinders.—The deflections calculated for every 1,000 yards and each 10 degree for a 10 mile wind are first tabulated, forming the "base table" for the given caliber and muzzle velocity. From this, by multiplication, similar tables are prepared for each wind velocity considered. The drift is now added, giving for each wind two tables, one for positive winds and one for negative. For all negative winds the resultant signs are all negative. For positive winds the signs depend on the relative effect of wind and drift, but usually negative up to 20 mile wind.

Similarly, range corrections are computed and tabulated. These results are now entered in their proper places on the divisions of the cylinders at the intersection of the corresponding range and angle.

Range and Azimuth Differences.—As these are both functions of range and azimuth it is evident that the same mechanical device will give these corrections. This would do away with the cumbersome and unsatisfactory difference chart. It would be better to make the device as an attachment to the gun for which these corrections are necessary.

AS AN ATTACHMENT TO THE GUN.

From the principles stated above, and as the gun reproduces the movements of the plotting ruler in azimuth, we can make the gun do the work of getting its own deflections for wind and drift, range corrections for wind, and range and azimuth differences. The number of such corrections to be given by the gun would of course depend on the particular system of fire used.

All that is necessary is to gear a shaft to the base ring, or similar rack which is stationary. As the gun turns the shaft will turn and by a suitable and simple reduction gear the cylinder is made to turn at equal angular speed to the gun itself. The cylinder may then be placed right before the gunner's eye for deflections, and the range corrections appear at the elevating wheel where they are applied by a shifting index. Range and azimuth differences can be given by a precisely similar arrangement, or the dust-guard may be utilized as a cylinder directly and the corrections shown on it. The azimuth differences as read would be applied to a shifting sub-scale, the index of which would then be set to the same azimuth as No. 1 gun. The range difference is similarly applied at the wheel.

By this means we do away with the difference chart and the indices can be kept set continuously. No. 2 gun, in Case III. is set as quickly as No. 1 and to precisely the same data as it comes from the plotting room.

IMPROVED DEFLECTION SCALE.

In sights and all similar apparatus designed to be worked under conditions of excitement, it is important to come down to the simplest possible form so arranged as to require little or no mental effort, and so that the man's primary and elementary ideas shall have full play. There should not be any confusion of ideas as is now often the case.

In the present sights we encounter at once several objectionable features, such as an algebraic deflection scale, wire moving in the opposite sense, lack of uniformity for different guns, etc. The horizontal wire and all elevation features for high power guns should be eliminated and the sight depended upon simply and only for deflections. The objections to the present telescopic sight are well known, such as the confusing motion of the wire, double micrometer scale, and the necessity of calculating before the deflection can be set by the micrometer.

OBJECTIONS TO THE PRESENT DOUBLE OR ALGEBRAIC DEFLECTION SCALE.

1. Getting the total deflection is an algebraic operation, of necessity more difficult and more liable to error than an arithmetical one would be. This especially in the case of enlisted men and under the conditions of action.

2. In modern artillery practice at moving targets, where the total deflection is the algebraic sum of the wind, drift, travel, and possibly error of last shot, the actual center of the deflection scale, or point indicating zero deflection, is a matter of no importance whatever. The wind may be either positive or negative, likewise the travel. The latter is also usually a large item. The actual setting on the scale is thus purely a matter of calculation and not largely a rule of thumb as was formerly the case in firing at fixed targets. Then it was possibly of some value to know the center of the scale and to be told to "throw into the wind, etc".

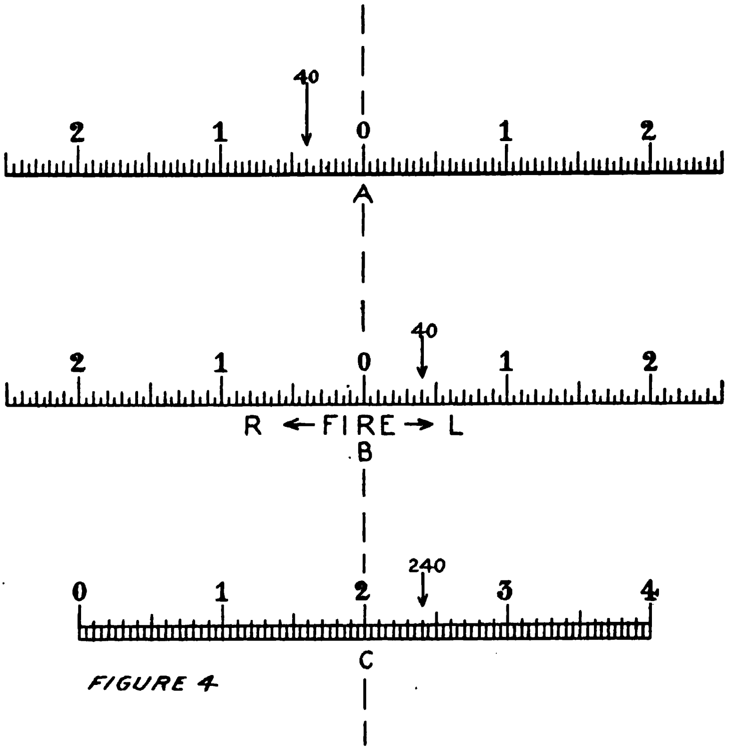


FIGURE 4

A represents present open scale.
B represents present telescopic scale.
C. Proposed form for all sights; setting shown for telescopic.
A setting of 40 left is shown in each case. If **C** were open, the setting for this deflection would be 160.
Graduation of 2 degrees on either side is considered ample.

3. At present the double scale introduces two kinds of errors in practice: a, errors of computation; b, errors in setting owing to confusing the terms "right" and "left," and also because the scale is an unnatural one in that it increases in two direc-

tions. There is also confusion in the Warner and Swasey sight in that when the gunner gets the command "Fire Right", he must move his wire to the left, etc. A confusion of ideas is involved, which, in turn, produces uncertainty of action. The most experienced gunners find this perplexing. There is another source of error. Suppose the command is "Fire Right 1.20." Looking to the left of the center the resting point for the eye is the figure 1. From that point, unless careful, he would go to the right naturally two divisions, and set at 80 right, or an error of 40.

In fact most of our errors in setting can be traced to similar causes, and such errors are very hard to loacte, and practically impossible to detect in rapid work. The essence of good fire direction is in careful attention to such small points as these.

PROPOSED FORM OF DEFLECTION SCALE.

All of the above objections are done away with, both in open and telescopic sights (both with fixed and with movable wire), by the proposed form of scale shown where the zero is placed at the extreme left. The advantages may be put as follows:

Computations.—Getting the total deflection is reduced to a simple arithmetical operation, involving but two numbers. The wind and drift is given by the corrector as a whole number, always larger numerically than the travel. There can thus be no negative settings and crossing of the zero is avoided.

Example:

Wind and drift, ...	240
Travel, ...	— 45
Setting, ...	195

and this result goes to the gunner as "Sight, one ninety-five." He sets it on the simplest form of scale, such as he has always been familiar with. On getting this command it makes no difference to him in which direction his wire must move to be at 195; nor does he know or care whether he is really giving a right or left deflection.

The above setting corresponds to a right deflection of 5, and a little consideration will show that the sign of the travel must be reversed from that ordinarily used. This could easily be provided in the mechanical device giving travel, and would cause no thought. This system enables the total deflection to be called off almost instantly as soon as the travel is determined.

Uniformity of Deflection Scales.—This is a matter of considerable importance, and is easily arranged. In all sights, of whatever design, the deflection scale would be of precisely the same form and the setting equally simple. The only difference would be that the actual numbers would be different. This is all effected in the graduation of the corrector. This uniformity of scales tends to prevent errors when a gunner passes from telescopic to open sights, etc., as will often be necessary in practice. In either case he has the same scale, and the same operation.

Simplification of Telescopic Sight.—The system outlined gives us at once a way of greatly simplifying the telescopic sight having a movable wire. With the new single scale we do away at once with all wording on both inside and outside scales, with "R" and "L," etc., and with one of the micrometer scales. The pitch of deflection screw is made double that at present, so that one turn equals one full degree. There can thus be no mistake made in setting fractions of a degree, provided the main index is between the proper degree limits. The outside scale has only even degree divisions. The inside scale is of precisely similar design to the outside, but divided to $\frac{5}{100}$.

With these changes the micrometer becomes our most accurate way of setting, whilst the present one with double scale is of no practical value. Settings can then be made on the micrometer and outside scale at leisure and during loading, and the setting verified on the inside scale. The eye fatigue is thus much reduced.

PROPOSED SYSTEM OF FIRE DIRECTION.

By Captain CLINT C. HEARN, Artillery Corps

In the Wadsworth System and in the Fort Monroe System up to September, 1903, it required at least two minutes after the first observation on the target before a shot could be fired. The plotting boards used were limited to 12000 yards. It will be seen then that any vessel running straight in, at maximum speed, would have been running at this speed for two minutes before a single shot could be fired at it. If a torpedo boat or destroyer, it would have advanced 1800 yards at the very least. If a cruiser, more than 1200 yards.

Now if the weather conditions were favorable, fire could be opened at 10200 yards and 10800 yards respectively ; but suppose they were unfavorable, such as an attacking fleet would wait for and take advantage of, it would be a rare case where a vessel could be picked up beyond 6000 yards, and much more frequently inside of that range. Thus under the old system a shot would rarely be fired at a target beyond 4000 yards. This allows no time for identification of target to secondary station, which would consume time that must increase the travel and delay the opening shot.

At the Barrancas test on April 22, 1903, the firing had to be suspended for that day on account of the haze. The target could not be seen beyond 6000 yards, notwithstanding it had been painted with the idea of making it visible. What would have been the condition had the target been a hostile vessel in "war paint?" This was in broad day with sun shining. Would searchlights on a night, hazy or foggy, do any better. I do not know.

The mines are there to be sure, but has any system been devised which will successfully prevent counter-mining, especially by submarine boats? Cannot an active enemy render the mine field absolutely harmless prior to an attempt to "run by" ? It was further noticed at the Barrancas test that the target, when nearing the end of the prescribed course, would never reach the "predicted point," but would make a complete turn inside of this point, and would, at times, stop before reaching the predicted point while on the course. In both cases a new predicted point had to be determined. If the two minute predictions were to be used what was to prevent an enemy, appreciating the conditions, from taking advantage of this fact and keeping the plotting room continually changing predictions and thereby delaying indefinitely the fire of the batteries or rendering the fire extremely inaccurate in case it was commenced.

Under the Fort Monroe System the same condition obtained. The set-forward point depended on the speed and direction of the target, and a new range and deflection must be made for every change in the components of the speed of the target. These ranges sent to the gun and plotted there on a black-board give the time-range relation when supplemented by a clock synchronous with the time interval bells in the stations. These predicted ranges thus posted are checked by the actual plotted course of the target on the plotting board, thus requiring a double operation and introducing an unnecessary complication. Why not hold the predicted ranges in the station until ready for use, and then send to the gun as often as necessary?

While more elastic than the Wadsworth System, in that the gun could be fired any moment after being loaded, it was still tied down to a long observation and predicting interval and could only be used with Case II., while the former system was committed, except at the shortest ranges, to Case III. Case III. is necessarily slower than Case II., and it may frequently be of the utmost importance to have the highest rate of fire. On the other hand the sight standard or sight may be put out of commission by a hostile shot, or the target may not be visible to the gunner, while it can be plainly seen by one or both base line stations. No system should be adopted which would exclude either method of laying the gun. "Synchronous clocks" are rarely synchronous.

Either system worked well at artillery practice, *after fire was opened, as long as the target kept its prescribed course and at a fairly uniform speed.* It may be safely assured that no fleet will attempt to enter a hostile harbor until that fleet has an accurate chart of the harbor, with the course accurately marked on land by its own agents or spies; otherwise it would court almost certain destruction or capture. Its counter-mining boats will completely buoy the channels, if false buoys have been placed by the defense they will be moved to mark the channels. Every channel permits some variation of the course of incoming and outgoing vessels. This variation will be utilized to its full limit by a hostile fleet.

To illustrate: Suppose the first shot goes slightly over, the vessel will crowd in toward the battery, forcing the next predicted point on the near side of the channel; then will immediately change to outer limits of the channel forcing the predicted point outside; then change back or continue outside as in the judgment of the captain seems wisest. He will see to it that he never travels on the same course for two minutes at a time, with the sole purpose of disconcerting the plotting room. In the plotting room will be heard "target turning," and a new prediction must be made, but the target will never reach the predicted point. The battery commander must then either fire, trusting the vessel has not deviated far enough to cause his shot to miss, or must wait for another prediction.

Another weak point of the prediction system was the necessity for clearing the board so that the predicting scale could be used, finding the predicted and set-forward (or set-back) points on the board, and then determining their ranges and azimuths (or deflection, Case II.) After these were determined, the corrections for atmosphere, velocity, tide, wind and drift, had to be applied before sending to the gun the data necessary to lay it; and while this predicting, etc., was proceeding the vessel tracking had to cease so far as the plotting board was concerned, or else the observing interval had to be long and the data thus found was not available until the two minutes had expired.

These considerations led me to propose a system of observations at short intervals, sending ranges and deflections to the guns every ten seconds in Case II., and in addition, azimuths every twenty or thirty seconds in Case III.; travel of target to be treated as a correction, for both range and direction; *all corrections to be applied in advance.* The system to be capable of changing from either Case to the other without interfering in any way with any part of the station or gun work, without the loss of a single observation and without delaying a single shot. To do this required certain mechanical devices to replace some of those already in use, the discarding of some, and the addition of others.

In developing this system I tried many and complicated devices, and finally condensed them all into the present proposed form of the gun arm on the Whistler plotting board, and an automatic ballistic board.

The automatic ballistic board gives *the aggregate corrections for range and for azimuth for the set-forward point of the actual present position of the target,* by simply setting at the range; when these corrections are applied on the gun arm they are carried on it, so that *when the arm passes through any plotted position of the target,* *the corrected range and azimuth to the set-forward point of that position may be read off at a glance.*

To demonstrate the practicability of vessel tracking with intervals of ten seconds and of correct gun laying without predictions, as the term implies in its technical sense, I made a gun arm of old brass from a condemned range finder, and placed it

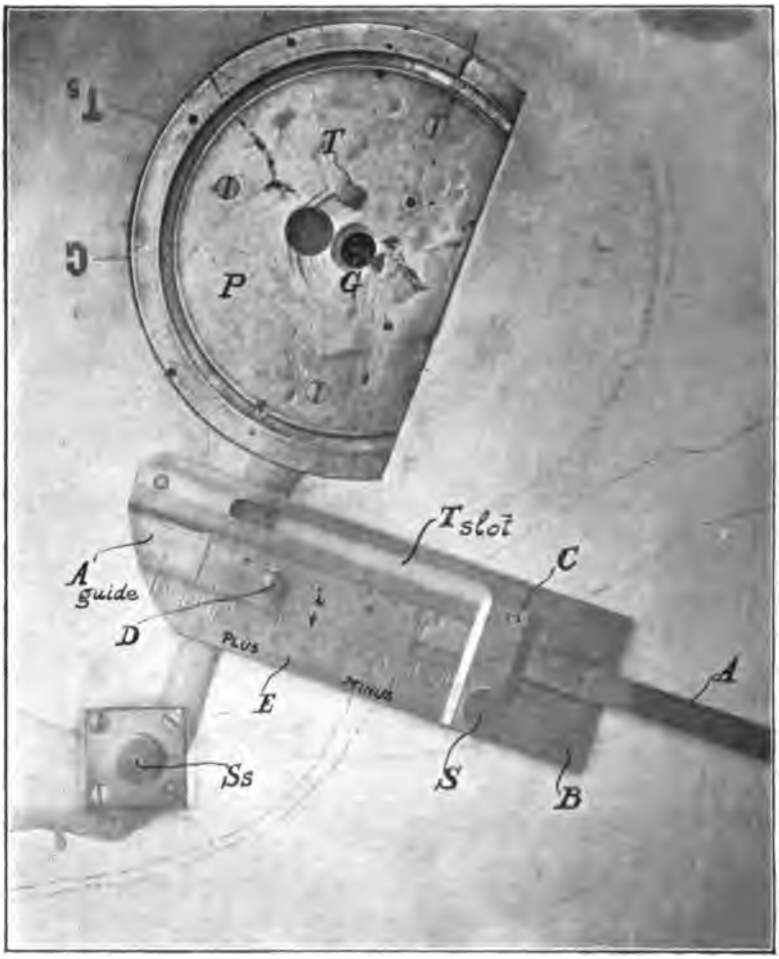


Fig. 1.

on the plotting board made by the class of Master Gunners at this post. The accompanying photographs show the details. **P** is a plate screwed to the plotting board, and having a hole **G** whose center is at the middle point of the battery, and another hole **T** in which the pin **T** is shown, fig. 1, whose center is at the position of the primary station of the horizontal base, on the plotting board. **Ss** is the secondary station on the board. **G**, fig. 2, is a slide with pin on lower face; the pin fits accurately in the hole **G** on plate **P**. A movable plate **B** rests on top of **P**; the slot **T**, figure 1, fitting accurately over pin **T**, is parallel to the range arm, the fiducial edge of which, prolonged, coincides with the middle line of slot, and therefore always passes through the point representing the primary station, no matter what position **T** occupies in the slot. It may thus be used to lay off, accurately, azimuths from the primary station and for this purpose is the station arm.

The slide **G**, fig. 2, fits accurately on the groove **G** on under side of movable plate **B**, which groove is perpendicular to slot **T**. **G** has a motion in this groove normal to the edge of the range arm. The upper side of the plate **B** is graduated to the same scale as the range arm, its zero being exactly over the middle line of the pin and hole **G**.

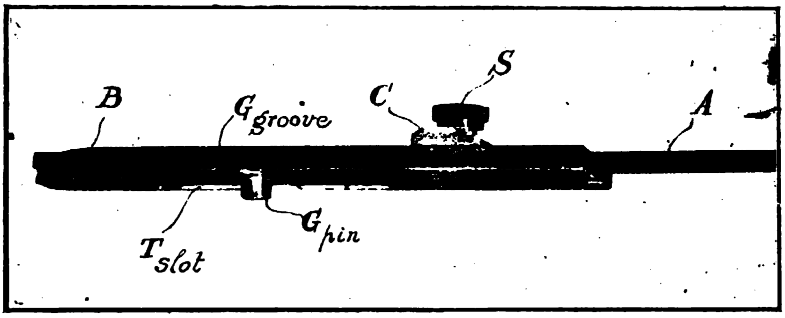


Fig. 2.

The plate **B** also has on its upper side an undercut guide **A** for the range and station arm **A** which is cut away on its fiducial edge to accurately fit this guide, and so that this edge will coincide with the middle line of slot **T** prolonged. The arm **A** can be moved in its own direction by unclamping **C** (using **S**), and sliding by means of pin **D**. The index i is placed at the zero of the range scale on **A**.

The pin **T** constrains the fiducial edge of the arm **A** to pass at all times through the primary station, while the pin **G** constrains the zero line of scale **E** to pass at all times through the directing gun or point.

Azimuths are read accurately from the primary station, and ranges approximately from the gun; approximately, because the range read is equal to the actual range into the cosine of the angle at the target, subtended by the station and gun.

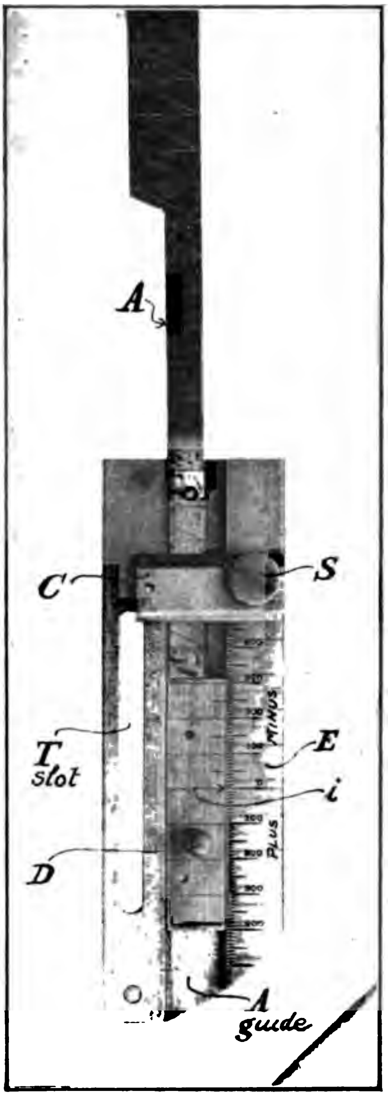


Fig. 3.

Let $R =$ range, and $\varphi =$ angle at target, and,
$E =$ error of range reading, then,
$$E = R - R\cos\varphi = R\,(1 - \cos\varphi) \qquad (1.)$$

E will be greatest when φ has its maximum value, which is true when the target is on the line normal to and bisecting the line joining the station and gun, and when target is at its nearest position to the battery on this normal line.

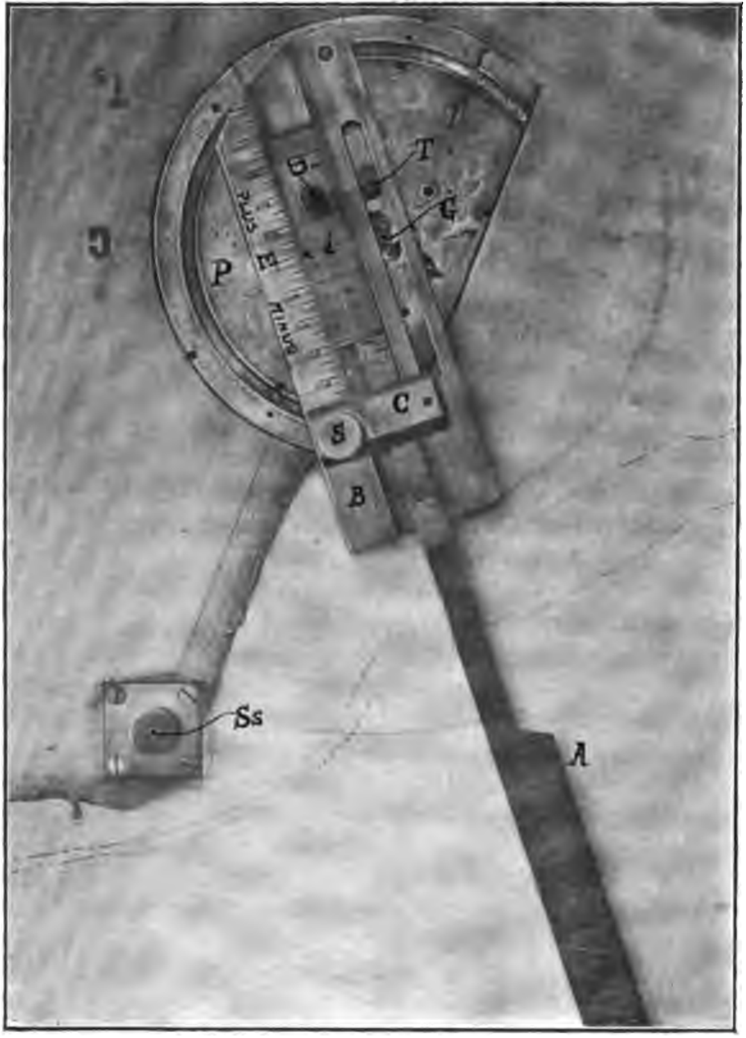


Fig. 4.

The maximum value of φ at any range may be found from the equation:

$$2 \sin \frac{1}{2}\varphi = \frac{d}{2R} \qquad (2.)$$

in which **d** equals distance from middle point of battery to primary station, and **R** the range. At Battery Church, Fort Monroe, **d** equals 172.34 yards.

E then is 1 yard at 12000 yards, and increases to 7 yards at 2000 yards for this battery, and is seen to vary with the danger space, and being so small is negligible.

Now, if the index **i** is set at, say, 120 yards on the plus side of scale **E**, on plate **B**, it is evident that all ranges read on **A** will be 120 yards greater than the actual ranges. If on the minus side of scale **E**, that much smaller than the actual ranges.

It can be shown that the aggregate range or azimuth correction, for any range, will remain practically the same for ranges greater or less by 200 yards. Hence, it is apparent that range corrections may be determined for ranges 200 yards ahead of the target, and set off on scale **E** ; and all ranges read on arm **A** will be the corrected range until the range has increased or decreased, as the case may be, by 400 yards. Deflection may be determined in the same manner, for some point which the target is approaching, and whose range does not differ more than 200 yards, nor by more than 5 degrees of azimuth ; and it will not change appreciably until the range has changed by 400 yards, and the azimuth by 10 degrees.

One man was assigned to the range corrections and another to the deflections, and neither had any other duty. They determined their corrections for a probable position ahead of the target and, before the target has passed that point by the allowable limit, each determined another correction ahead, and so on, as long as vessel tracking continued. The range corrector set his correction on the range arm. The deflection computer wrote his deflection on a pad and held it for the plotter to read into the breast transmitter.

From the last stroke of the time interval bell, until the gun was laid, occupied 3½ seconds. In determining the *range* correction for travel, five seconds, to cover the above time, was added to the time of flight; thus, if the time of flight for the range was 16 seconds, travel was corrected for, during 21 seconds.

To operate the system efficiently, the following men are required :

IN THE PRIMARY STATION.

No. 1. Observer.
No. 2. Reader.

IN THE SECONDARY STATION.

No. 1. Observer.
No. 2. Reader.

IN THE PLOTTING ROOM.

No. 1. Plotter and reader.
No. 2. Primary arm setter.
No. 3. Secondary arm setter.
No. 4. Range computer.
No. 5. Deflection computer.
No. 6. Telephone operator.

AT THE GUN.

The regular gun detachment, of which No. 6 is the range follower.

Plotting room members are connected as follows:

No. 1 by breast transmitter and head receiver telephone, with range follower at gun.

No. 3 in same manner with reader secondary station.

No. 2 by breast transmitter and head receiver speaking tube, with reader primary station.

All data goes direct from source to user without necessity for intermediate men.

The procedure was as follows:

Both observers kept vertical wire on indicated point of target until third stroke of bell, when they paused long enough for readers to call azimuth reading into their breast transmitters. Nos. 2 and 3 set their arms at the azimuth heard through their head receivers, and called "set". No. 1 read the range at intersection of arms, into his breast transmitter. Range follower immediately set his range wheel to the range heard through head receiver. These operations were repeated every ten seconds. Nos. 2 and 3 record their azimuths, and No. 1 his range, after each operation. No. 4 took the difference in range, due to travel for ten seconds, from No. 1's record, and with the range computer, found *the correction in range, due to travel during the time of of flight plus five seconds*. This correction he combined with the other range corrections determined from the Pratt ballistic board, and set the aggregate, affected by the proper sign, on the range arm. No. 4 watched the range record of No. 1, and the wind component dial worked by No. 5, and determined new range corrections about every 400 yards change in range and about every ten degrees change in azimuth, if correction elements are large; less frequently if small.

The general rule was to determine new corrections before the aggregate changed by ten yards. No. 5 took his angular travel during ten seconds from No. 2's azimuth record, and with the modified Lundeen computer, found the travel during the time of flight and combined it with wind and drift correction on the ballistic board. The aggregate he wrote on a pad and held where No. 1 could see it, who read it into his breast transmitter. No. 5 watched the ranges and the deflection component on the wind dial and determined new deflections whenever necessary to keep the error less than three hundredths of a degree.

The range follower at the gun, upon receiving his second range, could tell at a glance where the range pointer should be when the next range was heard, and with very little practice got the ten second interval so fixed in his mind, that by a continuous creeping motion of the range wheel, he kept the gun laid for range all the time.

So far as range is concerned, the gun was ready to be fired at any instant after the second observation was taken by the observers. The gunner laid for direction, the range follower calling up the deflection as soon as he heard it through his head receiver. While the gun was being loaded, it necessarily remained fixed in azimuth, but at the command "trip," the gunner caused the gun to be rapidly traversed up to, and kept his vertical wire on, the bow of the target until he heard the command "ready." He then signalled "halt," and when the part of the target to be attacked came up to the vertical wire, gave the command "fire".

The individual man had so little to do and his duties were so simple, that a perfectly green detachment was thoroughly instructed in half an hour and became expert in two hours drill. All the operations were entirely mechanical and required about that length of practice to acquire the dexterity necessary for rapid work.

It may be observed that by this system every point on the target's course has a predicted point just five seconds ahead of that point, and that the target is at one of these predicted points when the gun is laid on its corresponding set-forward point. With the high power guns, the corrected data reaches the gun before it is possible to load and trip it. Rapidity of fire is then *limited to the mechanical conditions of loading* and *controlled by the judgment of the fire or battery commander.*

There is nothing to get out of order ; the system is extremely simple and allows accurate laying without regard to the course and speed of the target. The home made gun arm described above gave the corrected and relocated range from the gun to the target, but would not relocate closely enough if the gun were more than 250 yards from the primary station. The gun arm on the Whistler plotting board is a further development of this one and is universal.

Case III. could be used with this gun arm, the range from the middle point of the battery and the azimuth from the primary station to the set-forward point being sent to each gun. A difference chart at each gun is then used to relocate the azimuth. Drills were had using Case III., predicting twenty seconds ahead under this system.

I had my company mechanic make a gun arm out of wood similar to the metal one and it gives almost as good results. I use the wooden one for instruction purposes. Any man who pretends to be a carpenter can make one.

While this form is not to be adopted, it answered the purpose for which it was designed, and can be put on any improved plotting board pending the new installation.

Figure 5 shows the azimuth corrector used for travel and figure 6 the range corrector for travel. After the first correction was made where a ten second interval was used, a thirty second interval for travel for each was substituted. It may be seen by inspection of figures 5 and 6 that this is practicable, gives more uniform results without changing the ten seconds observations, or sending data to the guns every ten seconds.

The "Deflection for travel," fig. 5, is a board **A** covered with cross-section paper and numbered to give the correction for deflection. The pin to which the thread is attached is at the zero for both time and deflection. The first horizontal line numbered in both directions is the "ten second" line, the second the "twenty second" line, and the third the "thirty second" line. The vertical scale then is a time scale and the horizontal scale a deflection scale. The T square **C** carries a range scale, ranges being used instead of corresponding times of flight. The T square slides in an under-cut groove. There is also an adding scale **B** sliding in an under-cut groove and having its zero in the middle; for the new sight the zero would be on the left, 300 at the middle and 600 at the right.

OPERATION.

Take the difference between two azimuth readings of the gun arm and draw thread, if azimuth is increasing, through number 44 right, fig. 5, (difference in azimuths) on time interval line, thirty seconds in fig. 5, (the interval between these observations); set adding scale so that arrow points to correction for wind and drift + 24-hundredths; slide T square till range to target (9,000 yards fig. 5) cuts thread; read deflection, + 49 hundredths. Always use the edge of the range scale toward the

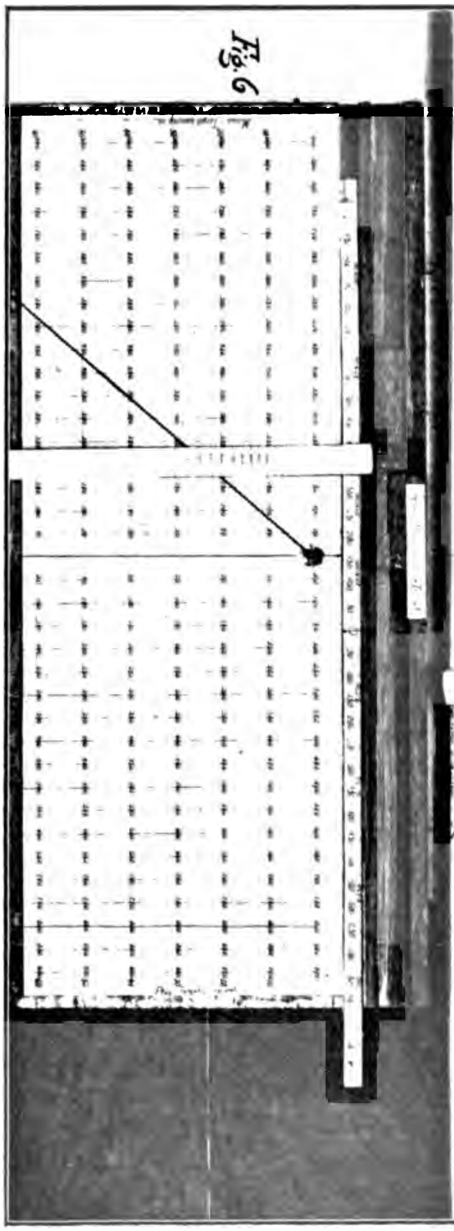


Fig. 6

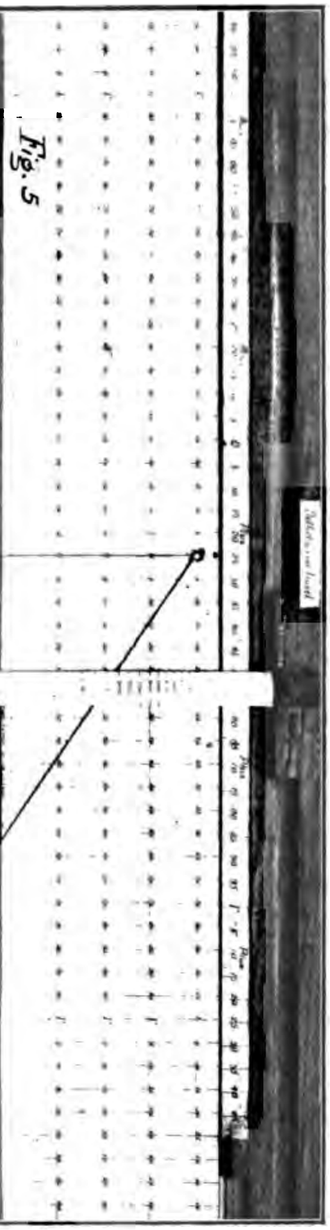


Fig. 5

zero on the adding scale, both when setting for range and when reading deflection. It is evident that the same edge of range scale must be used for reading as for setting on thread.

It is important that edge nearest zero should be used because it is natural to add rather than subtract. If right edge had been used and range had been 11,200 yards the operator would probably have + 63 instead of + 57.

The "Range Correction for Travel," fig. 6, is precisely the same except range differences are used instead of azimuth differences and the board is made wide enough for sixty second time interval. Its operation is evident.

This system could be used with great advantage with rapid-fire guns.

It is capable of furnishing data for laying the ideal gun, rapid-fire or high power, at its maximum rate of fire, in which the re-recoil from each discharge would load, trip and fire the next round.

While such a high rate of fire may never be obtained and rarely demanded by a land-naval engagement, it is better that the highest rate of fire of the land defense be limited by the mechanical features of the gun and carriage than by the defects or complications of the system of fire or battery control.

FIRE DIRECTION SYSTEM AS USED AT BATTERY SULLIVAN, FORT WILLIAMS, MAINE.

By Captain WILLIAM C. DAVIS, Artillery Corps.

It has been my own experience and that of most artillery officers with whom I have conversed that the best results at artillery practice (and also sub-calibre practice) with guns of 8-inch calibre and upwards have been obtained by employing Case II. This Case lends itself to great rapidity of laying the gun—the elevation being given by one man (or set of men) while the direction is maintained by the gunner. The two operations of elevating and directing are thus entirely independent of each other, and can be carried on simultaneously, while the division of labor is also conductive to accuracy, each man having one, and only one, operation to perform.

While, however, Case II. seems to be quite generally employed, many variations in the details of its operation, as worked out by different officers, will be found to exist. The following shows the scheme as employed by the author with great success first at Fort Carroll, Maryland, and more recently at Battery Sullivan, Fort Williams, Me.

In order to hit the target two conditions are necessary: First, that the telescopic sight, properly seated, adjusted and set with proper deflection, be on the target at the instant of fire; secondly, that the gun at that moment have the proper elevation for the shot to carry to the target after the elapsed time of flight.

As shown above, these two settings can be made entirely independently of each other. As employed by the writer the gunner at each piece is required to determine his initial deflection correction, adjust his sight properly therefor, and make all subsequent corrections.

For determining his initial deflection the gunner is given a small card, called the "gunner's deflection table," a copy of which (for the 10-inch B.L.R., M. V. 2250 f.s.) is given below. This deflection table is carried by the gunner, or preferably attached to the sight standard so as to be immediately under his eye at all times.

GUNNER'S DEFLECTION TABLE FOR 10-INCH B.L.R., M.V. 2250 F.S.

RANGE. YARDS.	TIME OF FLIGHT. SECONDS.	DRIFT. POINTS.	10 M. CROSS WIND. POINTS.
1000	1	0	0
1500	2	0	0
2000	3	1	0
2500	4	1	0
3000	4	1	1
3500	5	1	1
4000	6	1	1
4500	7	1	1
5000	8	2	1
5500	9	2	1
6000	10	2	1
6500	11	2	1
7000	12	3	1
7500	13	3	1
8000	14	3	2
8500	15	4	2
9000	16	4	2
9500	18	4	2
10000	19	5	2
10500	20	5	2
11000	22	6	3
11500	23	6	3
12000	24	7	3

In connection with this deflection table the gunner has impressed upon his mind the following principles:

1. To correct for *speed of target.* Always move vertical wire in direction *opposite* to that in which the target is moving.
2. To correct for *drift.* Always move vertical wire to the *right.*
3. To correct for *cross wind.* Always move vertical wire in *same* direction as the wind is blowing.

These three corrections are the only ones that need be applied for the determination of the deflection setting for the initial shot; ordinarily the first two—for speed and drift—only will necessarily be applied. The corrections should be applied *successively,* according to the principles above enunciated, so that there need be no error in addition or in miscomprehension of signs.

We will now illustrate the above by an example:

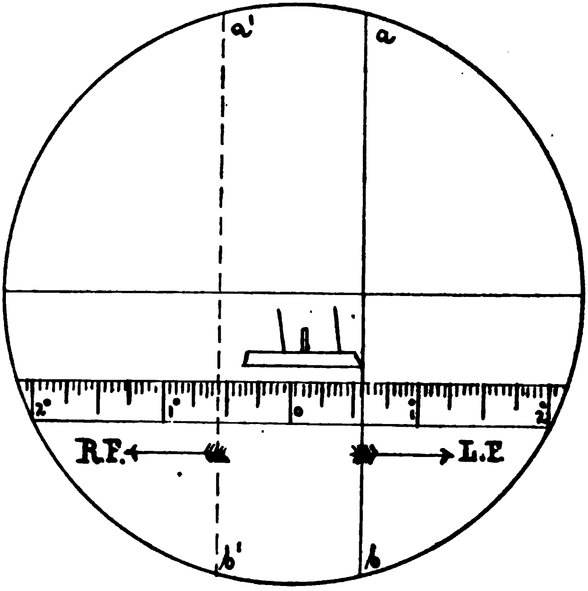
We will suppose that the works have been manned and that the gunner has his sight in the bracket of the sight standard, properly cross-levelled, focussed and checked by training on some distant datum point, the azimuth of which is kept posted in the emplacement.

The target is now indicated and the approximate range transmitted to the gun from the B. C. station. If there is an appreciable cross wind, that, too, is transmitted to the gun. We will suppose the data sent down to be as follows:

Approximate range..........................6200 yards,
Cross wind ....30 miles.

The gunner immediately causes the gun to be traversed in the direction of the target, which he nearly water-lines with the *scale*, takes from his deflection table the time of flight for the nearest entry (6000 yards = 10 seconds), sees that the vertical wire is on the zero of the scale, and causes the gun to be traversed until the line of sight is just in front of the bow of the ship (target), where he signals "halt". When the bow of the ship has advanced into line with the vertical wire, he begins to count seconds, "zero, one, two, . . . nine, ten," counting out aloud the time of flight, at the same time following the bow with the vertical wire, by means of the micrometer screw. At the end of the 10 seconds the vertical wire will appear at some place as **ab** (fig. 1.) Without taking his eye from the telescope, he immediately transfers the wire the same number (11) points on the opposite side of the zero of the scale, as at **a'b'** (fig. 1.) The sight is now corrected for speed of target, as per principle 1.

Fig. 1.



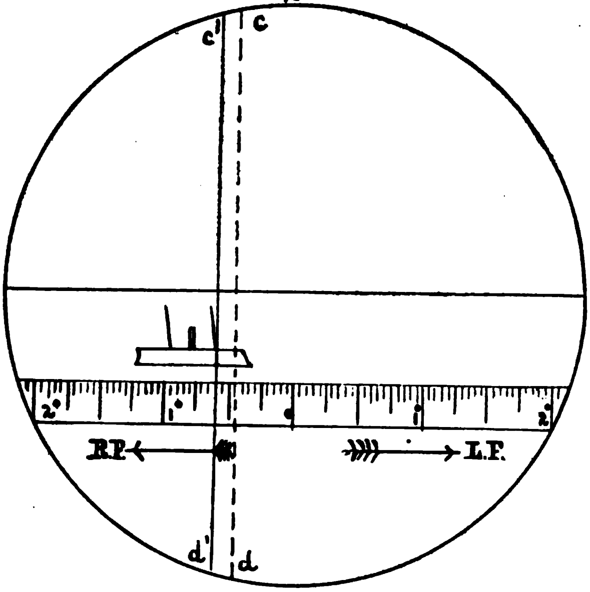
The gunner now takes from his deflection table the drift (2 points for 6000 yards), and immediately moves the vertical wire

2 points to the right, as shown in the dotted line **cd** (fig. 2.) The sight is now corrected for speed of target and for drift (principle 2).

He now takes from his deflection table the allowance for a 30 mile cross wind (3 points), and moves the vertical wire, in the direction the wind is blowing, from **cd** to **c′d′**, (fig. 2.) The sight is now corrected for *speed of target*, for *drift* and for *cross wind* (principle 3).

These corrections are all very simple, and are completed in a few seconds. As soon as the deflection has been set off as explained above, the gunner keeps the gun traversed so that the vertical wire (in its adjusted position) is kept slightly ahead of the midship section of the target, as shown by the line **c′d′** (fig. 2.) When the signal "time" (communicated to the guns from the B. C. station 5 seconds in advance of the epoch for firing) is heard, the gunner stops the traversing of the piece, permitting the target to pass by, until its midship section arrives on the vertical wire (fig. 3), when he fires the piece. Without removing his eye from the telescope, *or moving the vertical wire from its position* (**pq**, fig. 4), he notes where the shot strikes *with reference to the centre of the target*, by quickly estimating on the scale (which is made to nearly water-line the target) the deflection in points.

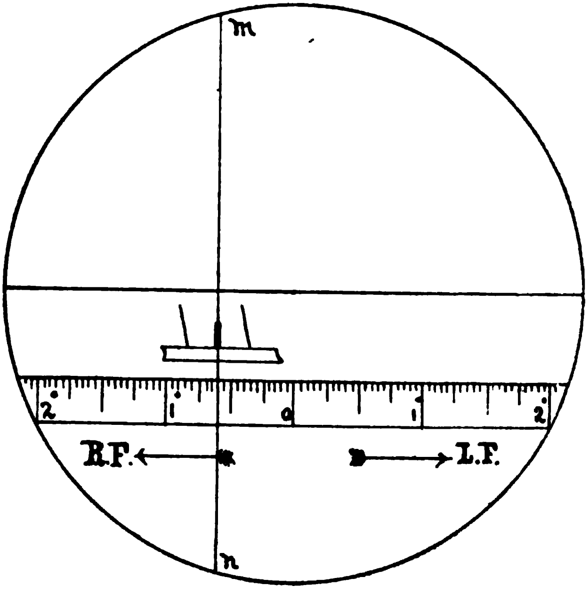
Fig. 2.



In fig. 4, the shot struck approximately 7 points to the right of the centre of the target (the point aimed at). Consequently, to correct for the next shot, the gunner merely shifts the vertical wire from its original position, **pq**, 7 points to the position **p'q'**, and the sight is adjusted for the next shot. This is, of course, on the assumption that there are no long delays between rounds, and that the target continues to maintain about the same course and speed. Of this the gunner can readily judge by observing through the telescope.

We may complete the principles above enumerated, then, as follows:

Fig. 3.

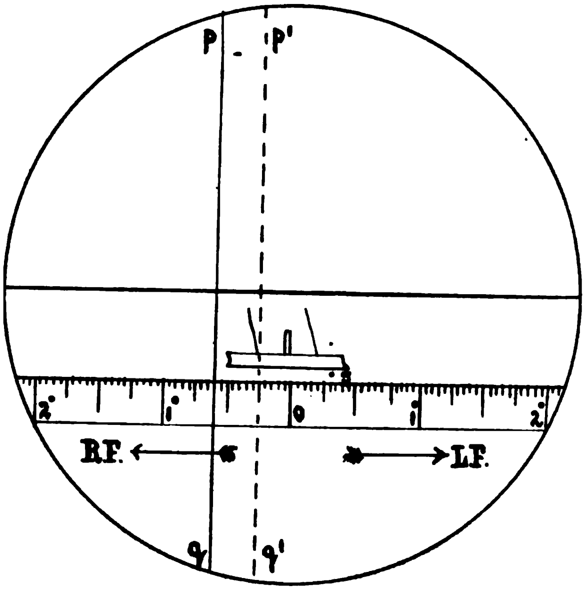


To correct sight from observed fall of preceding shot. Note on the deflection scale the number of points to the right or left of the centre of the target that the shot falls, and move vertical wire from its last position the same number of points in the same direction.

It might, at first thought, appear difficult for the gunner to count seconds with sufficient accuracy; experience shows however that this is not the case. The cadence is easily taught by requiring the man to walk in quick time, counting "zero, one, two, etc.," in succession as his left foot strikes the ground. He soon becomes familiar with the cadence, and able to call off the seconds, without marching, with great regularity. Repeated tests with the stop watch have shown that men can be readily trained to count off as high as fifteen or twenty seconds with an error not to exceed a single second.

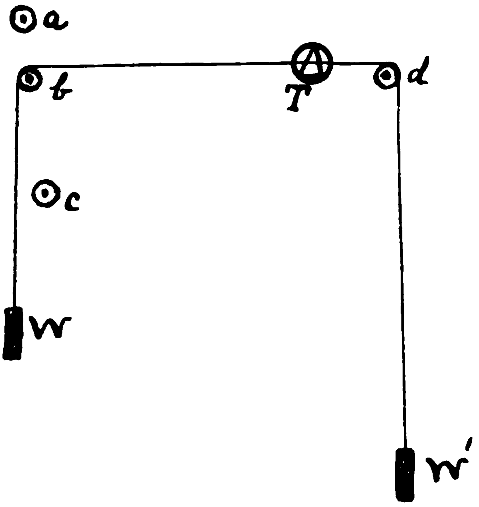
This scheme of requiring each gunner to make his own deflection corrections possesses many advantages. In the first place, the results are more accurate, the gunner in his sight having an instrument of precision better adapted for obtaining the deflection corrections than any instrument to be found in the B. C. station. Moreover, the B. C. station and the communication system are both relieved of the burden in connection with the obtaining and transmitting of deflection corrections, conducting to a more accurate and rapid computation and transmission of the ranges. Finally, if the B. C. station has to be abandoned, or if the gunner is assigned to a rapid-fire gun, his training with the sight makes him master of the situation, so far as obtaining line shots is concerned. The gunner, instead of blindly setting his sight as some one else has directed, has acquired a thorough knowledge of it, and can, by his experience, not only set it accurately in the first instance, but correct it to suit the varying speed or changing direction of the target. That this is not expecting too much of the gunner has been proved repeatedly both at sub-calibre practice and at the regular artillery practice.

Fig. 4.



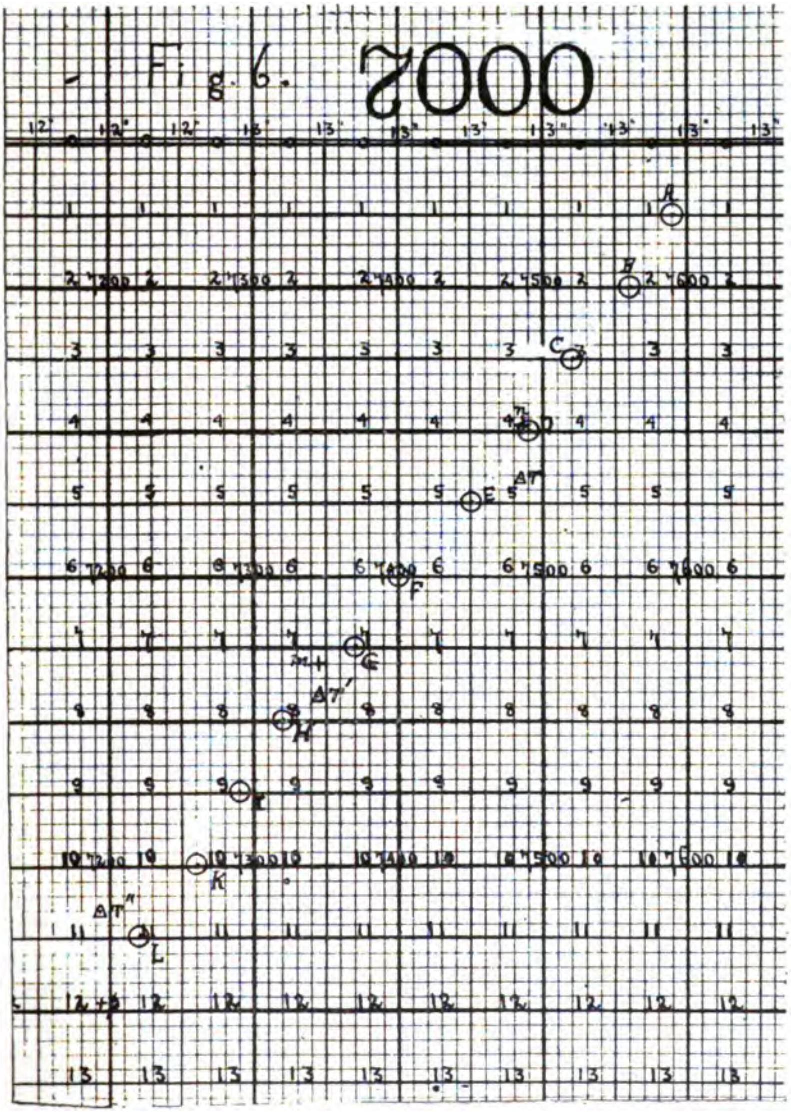
The principles involved in the use of the sight in Case II. are readily taught indoors by attaching the sight bracket to a post or door frame, and then, at a distance of some 50 or 75 feet, causing a small disk of white cardboard, with a black triangle on it (to represent the target) to move back and forth between two small pulleys a few feet apart. The arrangement is sketched in fig. 5. By using several pulleys, **a**, **b**, **c**, etc., different presentments, corresponding to what would appear on the water, are obtained. The gunner is told the "approximate range" and cross wind, and is required to adjust his sight from the data given. A tack is then placed near the target, to represent where the shot struck, and the gunner is required to set his vertical wire for the next shot, as per principle 4, above given.

Fig. 5



The Hagood tripod for telescopic sight, a description of which was given in the JOURNAL for July–August, 1903, would undoubtedly prove a most valuable auxilliary for the indoor training of gunners in the principles of the sight.

As explained above, the direction of the piece is left entirely in the hands of the gunner, so that the B. C. station has only to obtain and transmit the range. The following indicates the method used—the aim being to make everything as simple as possible. For this purpose a Time-Range Board is used, consisting simply of a strip of ordinary cross section paper, 20 inches wide, ruled to inches and tenths, pasted to a soft pine or poplar board, about 9 feet long and 21 inches wide. Ranges are reckoned longitudinally from 1000 yards to 12000 yards, while time is reckoned vertically. The scale for range is 1 inch = 100 yards; for time, ½ inch corresponds to successive equal time intervals at which the target is observed, being 15 seconds, 20 seconds, 25 seconds or 30 seconds, as may be chosen. Figure 6 shows a portion of the board. Time lines are numbered in red, range lines in black, at close intervals throughout the board. The time of flight, for each 50 yards of range, is noted at the top of the board.



The range corresponding to any observation is indicated by simply inserting a steel pointed toilet pin vertically into the board at the intersection of the corresponding time and range lines. Black-headed pins are used to mark ordinary observations; white-headed pins to mark predicted positions. About 4 black-headed pins and 2 white-headed are used—the first pins inserted being taken up as needed to mark the later observations.

We will now illustrate by an example.

We will now suppose that the battery commander wishes to deliver a round (or salvo) on the average of one per minute. We will suppose that the relocated ranges to the central point of the line of pintles, *not* directing gun, (thus doing away with difference charts at the guns) is called off from the D.P.F. (or from the plotting board if the H.P.F. be used) at 20 second intervals. On this time scale ½ inch corresponds to 20 seconds, or 1-10th inch corresponds to 4 seconds.

The black-headed pins are inserted by the operator in charge of the board successively at **A, B, C, D,** etc., as the ranges are called from the D.P.F. (fig. 6.)

At the first "take" (corresponding to **A**) the battery commander (or an assistant) starts his stop watch. When pin **B** has been inserted, the battery commander commands, "Predict." The operator takes a thin celluloid straight-edge, about 6 inches long, applies it against pins **A** and **B**, and immediately inserts a white-headed pin at the point **T**, in line with **A B**, and 40 seconds plus the 13 seconds time of flight (taken from the top line of the board) from the time line through **B.** (Practically, he passes over two half inches and then counts the tenths of inches as 4 seconds until he has made up the 13 seconds).

It requires about 3 seconds to insert the predicting pin and call off the predicted range. This range is immediately "corrected" by the computer, and the "corrected range" immediately telephoned to the guns. Allowing 15 seconds for the entire operation in the B. C. station gives 25 seconds at the guns; practically not more than 10 seconds are there required, there being no difference charts to use, nor deflection corrections to apply—only quadrant elevations.

As soon as the pin at **C** has been inserted, the operator applies his rule to the pins **B C**, and sees at once that it crosses the range line passing through **T** at the cross (+) marked **n.** In other words, the ship is going to arrive at the predicted range earlier than first appeared. He immediately informs the battery commander, "Fifteen seconds early, sir;" and the battery commander, instead of waiting the full minute, gives the signal to fire at 45 seconds, or as soon as he sees that the guns are "ready".

The battery commander's stop watch is set back to zero as soon as the round is fired, and started again at the next "take," which which will be the one corresponding to **D**. The positions **D** and **E** are marked, the command "predict" given, and the point **T′** determined as above indicated. As soon as **F** has been located, the rule is applied to **E F**, and is seen to intersect the range line through **T′** at **m**, and the operator calls off "Ten seconds early, sir".

Similarly the point **T″** is located, but in this case the ruler applied to **H I** indicates the point **p**, and the operator calls out, "Twenty-five seconds late, sir." This is confirmed by the application of the ruler to **I K** as soon as the observation corresponding to **K** has been taken, and the shot is fired at 1 min. and 25 secs. by the battery commander's stop watch.

The firing is done only by the gunner of each piece, or at the gunner's command. Five seconds before the time for firing, as determined by the battery commander, a signal by call bell, or the word "Time" by telephone, is transmitted to the guns. Each gunner then fires immediately the target is centered on his vertical wire.

For "fire at will," using ranges from the B. C. station, each gun is provided with a similar board, having an operator who keeps the ranges posted and who instantly informs the gun commander of the predicted range whenever it is desired.

With any scheme, the "proof of the pudding is in the eating." With much sub-calibre practice, I have found that the gunner, by the principles of the sight taught him, can always keep on the target and manage the deflection question. In fact, the less he is "assisted" by directions from the B. C. station, the better the firing. With the Time-Range Board equally accurate results in ranging have been obtained. Instead of firing on data two or three minutes old the range of the ship is checked to within 20 seconds of the moment at which the round is fired. During the joint maneuvers of 1903, the companies in the Artillery District of Portland received thorough instructions in systems of fire control and direction of more or less complexity, and following the maneuvers four times the regular allowance of ammunition was allowed and expended in artillery practice. Then, as now, Battery Sullivan, at Fort Williams, was manned by the 49th Company, Coast Artillery.

In the first series of 4 record shots of the after-maneuver's practice, Case III. was used.

The average range was	5300 yards.
Average lateral deviation	77 yards.
Average time per shot	1 min. 45 secs.
Percentage of hits	0 %.

In the last three series (of 14 record shots in all) Case II. was used; deflection and range corrections being worked out on pad by two "assistant observers".

The average range was	4800 yards.
Average lateral deviation	22 yards.
Average time per shot	1 min. 42 secs.
Percentage of hits	39%.

On November 23, 1903, (two months later) the same company, at the same guns, with essentially the same gun commanders, gunners and cannoneers—but using the methods outlined in this article, made the following score in 4 record shots:

The average range was	4800 yards.
Average lateral deviation	5.9 yards.
Average time per shot	1 min. 29 secs.
Percentage of hits	75%.

This score was made under a new company commander, after only about ten days' instruction in the scheme which we have described. Unfortunately, an error of 400 yards in receiving the range of the first record shot over the telephone at the gun, thereby causing that shot to fall short, prevented what should otherwise have been a perfect score.

In what precedes the underlying idea has been to simplify and de-centralize, bearing in mind that in action the time will surely come when the B. C. and the F. C. stations will go "out of commission," and the battle will have to be continued from the guns. This time may come much sooner than most of us would expect. Any system of fire direction which does not permit of continuing the action after the B. C. station is abandoned, without any change in the personnel or methods in use at the guns is in my opinion fundamentally wrong. For this reason I would use Case III. only in case of necessity, as with the mortars.

Give the gunner an automatic sight, so that he can correct for ranges as well as deflections when the B. C. station is abandoned, and we shall increase the efficiency of our guns by 100%; add to this a reflecting sight attachment, so that the gun at close quarters (say within 1500 yards) can be loaded, aimed and fired without a cannoneer exposed, and we shall come close to perfection.

THE ACCURACY AND PROBABILITY OF GUN-FIRE.

By Professor PHILIP R. ALGER.

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If a great number of rounds are fired from a gun, under as nearly as possible the same circumstances, it will be found that the impacts (which we will suppose to be received upon a vertical screen perpendicular to the plane of fire) are grouped closely together around one point and are more and more widely separated as the distance from that point increases.

The point about which the impacts are most closely grouped is called the *mean point of impact*, and its coordinates with reference to any axes **Z, Y**,—say the lower and the left hand edges of the vertical screen,—are simply the averages of the coordinates of all the impacts with reference to the same axes. In other words, the mean point of impact is the center of gravity of the impacts, regarding them as equal masses, and its coordinates are $\frac{\Sigma z}{n}$ and $\frac{\Sigma y}{n}$ where z_1y_1, z_2y_2, &c., are the coordinates of the **n** impacts.

The trajectory from the gun to the mean point of impact is called the *mean trajectory*, and the divergencies of the trajectories of particular shots from the mean trajectory have a multitude of independent causes, such as,—an initial angular deviations; variations of the muzzle velocity; variations of the form and weight of the projectiles; variations in the angular position of the gun when it is fired, and in its jump; variations in the force and direction of the wind; and variations in the drift due to rotation.

If the actual mean initial velocity is that for which the sights of the gun are graduated; if the range is exactly known and the sights are set accordingly; if the density of the air is standard; and if there is no wind and no motion of gun or target; then the mean point of impact will coincide with the point at which the line of sight is directed. These conditions, however, are never fulfilled, nor is it possible to compensate exactly for their nonfulfillment, and consequently the mean point of impact is never exactly at the center of the target. To bring it as near as possible to that point is the object of the *regulation of gun-fire*.

For the present we will not concern ourselves with the position of the mean point of impact relative to the target, but will consider only the distribution of the impacts about the mean point of impact.

The deviations of projectiles from their mean point of impact are closely analogous to what are called "accidental errors,"—such, for example, as are made in the direct measurement of a magnitude of any kind,—and they obey the same laws. Small deviations are more frequent than large ones; positive and negative deviations are equally probable, and are therefore equally frequent, if the number of shots is great; very large deviations are not to be expected at all (if one occurs, it must be due to some avoidable mistake). We will designate a lateral deviation by Δ_z and a vertical deviation by Δ_y, and we will assume that they are completely independent of one another,—i.e., that any particular lateral deviation is just as likely to occur simultaneously with one vertical deviation as with another. We will also designate the *mean lateral deviation* by γ_z and the *mean vertical deviation* by γ_y, the mean deviation being the arithmetical mean of all the deviations in the stated direction regardless of sign.

The *probability* of a future event is the numerical measure of our reasonable expectation of its happening. Thus, knowing no reason to the contrary, we assign an equal probability to the turning up of each of the six different faces of a die at any throw, and we say that the probability that an ace, for example, will turn up is measured by the fraction $\frac{1}{6}$. This does not mean that we should expect an ace to turn up once and once only in every six times, but merely that in a great number of throws (n) one may reasonably expect very nearly $\frac{n}{6}$ aces to be thrown and that the greater n is, the more likely it is that the result will agree with that expectation.

If an event may happen in **a** ways and may fail in **b** ways, each of the a+b ways being equally likely to occur, the probability of its happening is $\frac{a}{a+b}$ and the probability of its failing is $\frac{b}{a+b}$, and the sum of these two fractions, unity, represents the certainty that the event will either happen or fail. Thus, if the probability of an event happening is **P**, the probability of its not happening is 1—P. For example, since of the 52 different cards which may be drawn from a pack, 13 are spades, the probability that a single card drawn from a pack will be a spade is

$\frac{13}{52}=\frac{1}{24}$, while the chance that it will not be a spade is $1-\frac{13}{52}=\frac{39}{52}=\frac{3}{4}$.

If the probability of one event happening is **P** and that of another, independent, event happening is **Q**, then the probability of both events happening is the product of **P** and **Q**. For example, the probability of a single card drawn from a pack being a face card is $\frac{12}{52}$, and the chance of its being a spade is $\frac{13}{52}$; therefore the chance of its being either king, queen, or knave of spades is $\frac{12}{52}\times\frac{13}{52}=\frac{3}{52}$.

When we consider the deviation of projectiles, we are no longer dealing with definite numbers of equally probable events, but with values which may be anything whatever between certain limits. We cannot assign any finite measure to the probability that a deviation shall have a definite value because the number of values it may have is unlimited; we can, however, measure the probability that a deviation will fall between certain limits, or that it will be greater, or less, than an assigned quantity.

Suppose, for example, that a very large number (n) of shots have been fired, and that, their lateral deviations having been measured, it is found that **m** of these deviations are between 2 feet and 3 feet (either plus or minus); then we say that the probability (in any future trial under similar circumstances) of a single shot having a lateral deviation between 2 and 3 feet is $\frac{m}{n}$. Or if, of the **n** impacts, **q** were less than 4 feet to one side or the other of the mean point of impact, we should say that the probability of the lateral deviation of any single shot being less than 4 feet is $\frac{q}{n}$. The following actual case will serve as an illustration, although **n** is not so large as it should be.

On December 17, 1880, at Krupp's proving-ground, at Meppen, 50 shots were fired from a 12 cm. siege gun at 5° elevation, giving a mean range of 2894.3 meters. The points of fall being marked on the ground, their distances from assumed axes were measured, and the mean point of impact thus determined. Measuring the lateral deviations from this mean point of impact to the right, 14 were between 0 and 1 meter, 8 between 1 and 2 meters, and 2 between 2 and 3 meters; to the left 13 were between 0 and 1 meter, 8 between 1 and 2 meters, and 5 between 2 and 3 meters, and the mean deviation was 1.07 meters. Taking horizontal and vertical axes through the mean point of impact; laying off equal spaces to left and right of the origin, each representing one meter; and constructing on each space a rectangle whose height represents, on any convenient scale, the number of shots whose lateral deviation was within the limits corresponding to the space, we obtain fig. 1.

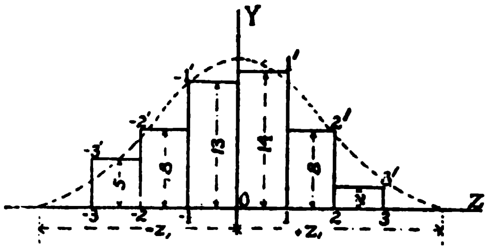

Fig. 1.

It will be seen that the distribution of the deviations is fairly symmetrical to the **Y** axis, there being 26 to the left and 24 to the right; also that the maximum does not exceed three times the mean deviation; also that the area of each rectangle divided by the whole area of the figure is the measure of the probability (as defined) that any single deviation will fall within the limits represented by its base. Thus area O $11' = 14$, divided by total area$=50$, is the probability$=\frac{14}{50}$ of any single deviation being between 0 and + 1 m.; area $11' - 1 - 1' = 27$, divided by total area$=50$, is the probability$=\frac{27}{50}$ that any single deviation will be between + 1 m. and—1 m.; and the total area$=50$, divided by itself, is the probability$=\frac{50}{50}=$certainty that no deviation will exceed 3 m.

If now the number of shots is increased, while the width of the horizontal spaces is diminished in the same proportion, the area of each rectangle divided by the whole area of the figure will continue to measure (with increasing accuracy) the probability of a deviation falling within the limits represented by its base. At the limit, when the number of shots is infinite and the width of the horizontal spaces has been reduced to the infinitesimal **dz**, the height (y) of each rectangle will still be finite; the upper contour of the figure will become a curve approximately like that shown as a dotted line; the area of each rectangle (now become the elementary area **ydz**) divided by the whole area under the curve $\left(\int_{-z_1}^{z_1} ydz\right)$ will still measure the probability that a deviation will fall within the limits represented by its base (between z and $z+dz$); and the area between any two ordinates of the curve $\left(\int_{b}^{a} ydz\right)$ divided by the whole area will still measure the probability that a deviation will be between **a** and **b**.

The curve just described is the *probability curve* for the lateral deviations of the projectiles of the particular gun considered, and while the probability curve for the vertical deviations, or that for either lateral or vertical deviations in the case of any other gun, would differ somewhat from this particular curve, all would present the following general features: (1.) Since plus and minus deviations are equally likely to occur, the curve must be symmetrical to the right and left of the origin, which is the mean point of impact. (2.) Since the deviations are made up of elemental deviations which, as they may have either direction, tend to cancel one another, small deviations are more frequent than large ones, so that the maximum ordinate occurs at the origin. (3.) Since large deviations (which can only result when most of the elemental deviations have the same direction and their greatest magnitude) are rare, and deviations beyond a certain limit do not occur, the curve must rapidly approach the horizontal axis both to right and left, so that the ordinate (which can never be negative) practically vanishes at a certain distance from the origin.

If $y=\psi(z)$ is the equation of the probability curve, the general features just stated require, (1) that $\psi(z)$ shall be an even function, that is, a function of z^2, (2) that $\psi(0)$ shall be its maximum value, (3) that it shall be a decreasing function of z^2 and shall practically vanish when z is large. Since it is impracticable to select the function ψ so that $\psi(z)$ shall be constantly equal to zero when z exceeds a certain limit, the last condition requires that the curve shall have the axis of z for an asymptote; in other words, we must have $\psi(\pm\infty)=0$.

The foregoing characteristics being thus established, and taking as its basis the axiom that the arithmetical mean of the observed values (made under similar circumstances and with equal care) of any quantity is its most probable value, the theory of accidental errors deduces as the equation to the probability curve,

$$y = \frac{1}{\pi\gamma}\varepsilon^{-\frac{z^2}{\pi\gamma^2}}$$

In which γ is the mean error, or in our case the mean deviation,

$\pi = 3.14159$, and $\varepsilon = 2.71828$, and the factor $\frac{1}{\pi\gamma}$ has been introduced to make the whole area under the curve equal to unity $\left(\int_{-\infty}^{+\infty} \varepsilon^{-\frac{z^2}{\pi\gamma^2}} dz = \pi\gamma\right)$ thus obviating the necessity of dividing a partial area by the whole area (in the manner described above) whenever a probability is to be computed.

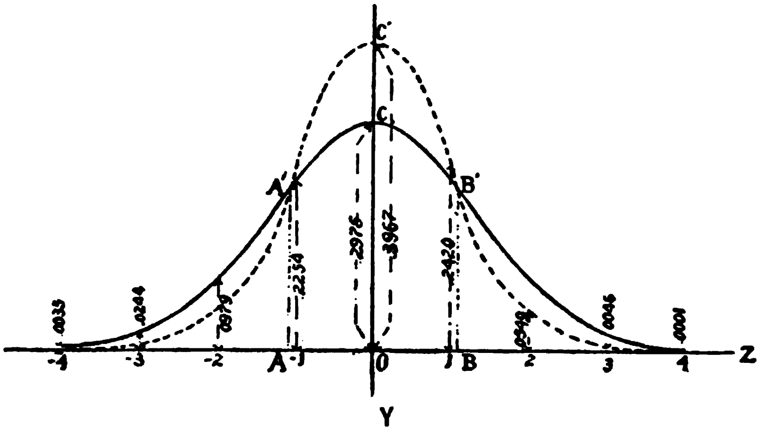

Fig. 2.

Figure 2 represents the probability curve for the Krupp 12 cm. siege gun, taking its mean error to be 1.07 meters, as given by the 50 shots referred to above; also, in dotted lines, for comparison, the probability curve for a gun whose mean error is ¾ that of the 12 cm. gun. In both curves the ordinates are exaggerated ten times as compared with the abscissæ.

The maximum ordinate, being the value of y when $z = 0$, is inversely proportional to the mean deviation $\left(y\Big]_{z=0} = \frac{1}{\pi\gamma}\right)$: the probability that a deviation will be less than OB=OA is the numerical value of the area AA'CB'B in the one case and AA'C'B'B in the other case; the probability that a deviation will exceed OB=OA is the area under that part of the curve which is to the left of AA' and to the right of BB': the whole area under each curve has the numerical value one. It will be seen how very small is the probability of any deviation exceeding three times the mean deviation.

The probability (P) that the deviation of any single shot will be numerically less than a given quantity (a) being measured by the area between the ordinates of the probability curve at

$z=+a$ and $z=-a$, and that curve being symmetrical to the axis of Y, we have

$$P=\frac{2}{\pi\gamma}\int_{0}^{a}\epsilon^{-\frac{z^2}{\pi\gamma^2}}dz.$$

The following table gives the values of P, calculated from this equation, but arranged for convenient use with the ratio $\frac{a}{\gamma}$ as the argument. Knowing the mean lateral deviation (γ_z) of a gun, to find the probability of a shot striking within the distance **a** to right or left of the mean point of impact, it is only necessary to take from the table the value of P which corresponds to the argument $\frac{a}{\gamma_z}$. And so, too, the probability of a shot striking within the distance **a** above or below the mean point of impact is the value of P which corresponds to the argument $\frac{a}{\gamma_y}$, γ_y being the mean vertical deviation.

Probability of a deviation less than a in terms of the ratio $\frac{a}{\gamma}$.

$\frac{a}{\gamma}$	P	$\frac{a}{\gamma}$	P	$\frac{a}{\gamma}$	P	$\frac{a}{\gamma}$	P
0.1	.064	1.1	.620	2.1	.906	3.1	.987
0.2	.127	1.2	.662	2.2	.921	3.2	.990
0.3	.189	1.3	.700	2.3	.934	3.3	.992
0.4	.250	1.4	.735	2.4	.945	3.4	.994
0.5	.310	1.5	.768	2.5	.954	3.5	.995
0.6	.368	1.6	.798	2.6	.962	3.6	.996
0.7	.424	1.7	.825	2.7	.969	3.7	.997
0.8	.477	1.8	.849	2.8	.974	3.8	.998
0.9	.527	1.9	.870	2.9	.979	3.9	.998
1.0	.575	2.0	.889	3.0	.983	4.0	.999

As an illustration of the use of the table, we will find the probability of the deviation not exceeding 1 meter and 2 meters in the case of a gun whose mean lateral deviation is 1.07 meters, and will compare our results with those given by the actual firing of 50 shots from the Krupp 12 cm. gun. Taking $a=1$ meter, we have $\frac{a}{\gamma}=.935$, and $P=.544$: the probability that the lateral deviation of a single shot will not exceed one meter is .544; therefore of 50 shots 27 should fall within one meter on either side of the mean point of impact; actually 27 did so fall. Taking $a=2$ meters, we have $\frac{a}{\gamma}=1.87$, and $P=.864$; the probability that the lateral deviation of a single shot will not exceed 2 meters is

.864; therefore of 50 shots 43 should fall within 2 meters on either side of the mean point of impact; actually 43 did so fall.

If **P** is the probability that the deviation of any single shot will not be greater than **a**, then evidently 100 **P** will be the probable number of shot out of 100 which will fall within the limits ±**a**; in other words, 100 **P** is the percentage of hits to be expected upon a band **2 a** wide with its center at the mean point of impact. Thus we see, from the table, that the half width of the band which will probably receive 25 % of the shot is 0.4γ, while the half width of the band which will probably receive 50% of the shot is 0.846γ. These facts are usually expressed by saying that the widths of the 25% rectangle and of the 50% rectangle are respectively 0.80 and 1.69 times the mean error.

The half width of the 50% rectangle is known as the *probable error*, or in our case the *probable deviation*, since it is the error, or deviation, which is just as likely to be exceeded as it is not to be exceeded.

If we wish to find the probability of hitting an area whose width is **2 b** and whose height is **2 h**, since the lateral and vertical deviations are independent of one another, the probability is the product of the two values of **P** taken from the table with the arguments $\frac{b}{\gamma_x}$ and $\frac{h}{\gamma_y}$, where γ_x and γ_y are the mean lateral and the mean vertical deviations respectively. Thus, supposing γ_x to be 4 feet and γ_y to be 5 feet, the probability of hitting with a single shot a 20-foot square with center at the mean point of impact is $P_1P_2 = .954 \times .889 = .848$, $P_1 = .954$ being the value of P for $\frac{b}{\gamma_x} = \frac{10}{4} = 2.5$ and $P_2 = .889$ being the value of P for $\frac{h}{\gamma_y} = \frac{10}{5} = 2$.

THE MEAN ERRORS OF GUNS.

We have thus far only considered the chances of hitting when the mean point of impact is at the center of the target, but this is very far from being an attainable condition in the service use of guns, especially of naval guns. Even with a stationary target, at a known range, it is difficult so to regulate the fire as to bring the mean point of impact, after a few trial rounds, close to the center of the target, and when the target is moving, with a speed and in a direction both only estimated, when the range is but approximately known, and when the gun itself is in motion, the most expert regulation of the fire by observation of the points of fall can do no more than to keep the mean point of impact in the neighborhood of the object attacked.

Let **O** be the mean point of impact, and **ABCD** the target (figure 3) at any moment, and let the coordinates of the center of **ABCD**, with reference to vertical and horizontal axes through **O**, be y_0 and z_0; also let the mean vertical and lateral deviations be γ_y and γ_z respectively, and let the dimensions of the target be 2 h and 2 b. Then the probability of a shot falling between the vertical lines **Cc** and **C′c′** is the tabular value of **P** for the argument $\frac{z_0+b}{\gamma_z}$ (which we will call $P_z(z_0+b)$), and the probability of a shot falling between **Dd** and **D′d′** is the tabular value of **P** for the argument $\frac{z_0-b}{\gamma_z}$ ($P_z(z_0-b)$). Therefore the probability of a shot falling between **Cc** and **Dd** is one-half the difference of the two preceding probabilities, or $\frac{1}{2}[P_z(z_0+b)-P_z(z_0-b)]$. Similarly the probability of a shot falling between the horizontal lines **C′ C** and **B′B** is $\frac{1}{2}[P_y(y_0+h)-P_y(y_0-h)]$. Hence the probability of hitting **ABCD** is the product of these two quantities, or $\frac{1}{4}[P_z(z_0+b)-P_z(z_0-b)][P_y(y_0+h)-P_y(y_0-h)]$.

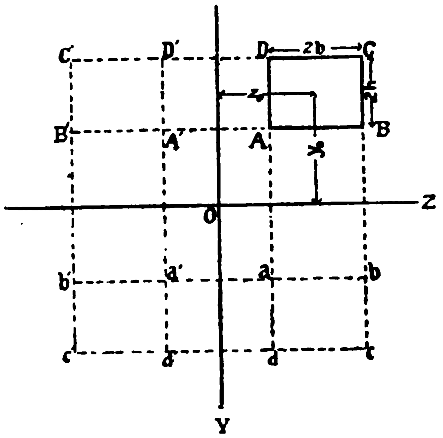

Fig. 3.

To illustrate, suppose we wish to find the probable percentage of hits on a gun-port 4 feet square, if the mean point of impact is 3 feet to one side and 4 feet below the center of the port, the value of γ_z being 3.72 feet and that of γ_y being 4.14 feet. Here we have $P_z(z_0+b)=P_z(5)=.717$; $P_z(z_0-b)=P_z(1)=.170$; $P_y(y_0+h)=P_y(6)=.751$; $P_y(y_0-h)=P_y(2)=.298$. Therefore the probability of hitting the port is $\frac{1}{4}(.717-.170)(.751-.298)=\frac{1}{4}\times.547\times.453=.062$, and the percentage of hits would be 6.2. Under the same circumstances, but with the mean point of impact at the center of the port, the percentage of hits would be 9.9.

Evidently the less the mean errors of a gun the more important it is to regulate its fire accurately; if the distance of the mean point of impact from the target is more than three times the mean error of the gun there will be practically no hits at all.

To illustrate the preceding statement, we will take the case of a 6-inch gun firing at a heavy gun position, 25 feet high by 32 feet in diameter and 3000 yards distant. Supposing the mean vertical and lateral deviations each to be 10 feet; if the mean point of impact coincides with the center of the target, the probable percentage of hits will be found to be 54.3; but if the sights are set for a range 10% more or less than the true distance the mean point of impact will be raised, or lowered, about 43 feet, and the percentage of hits will be reduced to 0.7. If, on the other hand, the mean errors of the gun were each 20 feet, or double what was first assumed, while the percentage of hits with perfect regulation of the fire would be reduced to 18.2, that with sight setting for a range 10% in error would be increased to 4.7. Thus se see that a gun may be severely handicapped by its own accuracy if the range is not known within 10%.

If we know the percentage of hits at a given range on a target of given size, we can make a rough estimate of the mean errors of the gun by assuming that the mean point of impact was at the center of the target, and the greater the number of rounds fired the more nearly correct will the determination probably be. For example, the eighty 6-inch guns of certain British ships, firing separately, made 295 hits out of 650 rounds fired, 45.4% of hits, on a target 15 feet high by 20 feet wide at a mean range of 1500 yards. Here we have given that the product of $P\left(\frac{10}{\gamma}\right)$ by $P\left(\frac{7.5}{\gamma}\right)$ is .454, and by a process of trial and error we readily find from the table that γ is slightly less than 7 feet, since $P\left(\frac{10}{7}\right)$ by $P\left(\frac{7.5}{7}\right) = .745 \times .581 = .432$.

The number of rounds necessary to make at least one hit is determined as follows: Let p be the probability of hitting with a single shot; then $1-p$ is the probability of a single shot missing; and $(1-p)^n$ is the probability that all of **n** shots will miss; hence the probability of hitting at least once with **n** shots is $P = 1-(1-p)^n$. Solving this equation for **n**, we have $\log(1-P) = n \log(1-P)$; $n = \frac{\log(1-P)}{\log(1-p)}$; and by giving **P** a value near unity we can find the value of **n** which will make one hit as nearly certain as we wish. As an illustration, taking a case in which

94 shots were fired from a mortar at a Gruson turret and in which the calculated probability of a hit with a single shot was .011, let us see how many rounds should have been fired to make the probability of at least one hit .95. In that case $p=.011$, and so we have $n=\frac{\log(1-.95)}{\log(1-.011)}=\frac{8.69897\,(-10)}{9.99520\,(-10)}=\frac{-1.30103}{-0.00480}=271$; so that 271 shots must be fired to make the odds 19 to 1 that there will be at least one hit. The probability of at least one hit with the 94 shots actually fired was $P=1-(1-p)^{94}=1-.354=.646$.

The Mean Errors of Guns on Steady Platforms. The deviations of the projectiles fired from a gun on a steady platform, the mean of which we will call the mean error of the gun, lateral or vertical as the case may be, are principally caused by (1) errors of the gun pointer in sighting the gun, (2) an initial angular deviation of the projectile, (3) variations of the muzzle velocity, and (4) differences between the projectiles.

With open sights the most expert gun pointers make a considerable angular error, which varies from round to round, when they point a gun by directing its line of sight at a mark. With telescopic sights this error is greatly lessened, but still exists. There is also always an error in setting the sights (we suppose the range to be unchanged, but the sights to be reset for each round). *The mean angular error of sighting* can only be estimated, but it is unlikely that it is less than one minute, even with the telescopic sight, under ordinary conditions of rapid firing; the resulting mean deviation at 2000 yards' range would then be about 21 inches, and may be taken to occur indifferently in all directions, though it is somewhat greater vertically than laterally. Such a deviation is equivalent to a mean vertical deviation of $\frac{21}{\sqrt{2}}=15$ inches together with a mean lateral deviation of the same value.

The initial angular deviation results from the projectile not leaving the gun in the exact line of the latter's axis. This deviation, which occurs indifferently in all directions, was quite large with smooth-bore guns and with some of the early rifles, but with modern guns, using projectiles rotated by forced bands, its mean value is probably not more than half a minute of arc. The mean deviation of the projectiles at 2000 yards' range would be about 10.5 inches by reason of this cause, and this is equivalent a mean vertical deviation of $\frac{10.5}{\sqrt{2}}=7.5$ inches together with a mean lateral deviation of the same value.

With all powders the muzzle velocity varies from round to round, no matter what care be taken to insure uniformity of the charges. With the gun cotton smokeless powder now used in the U. S. Navy, if the charges have been made up with proper care, and the projectiles are all of the same weight, the average difference between the velocities given by successive rounds and the mean velocity of all the rounds fired on any one occasion will probably not exceed 10 f.s. That is, if a large number of rounds are fired, and the average velocity is, say 2400 f.s., then probably no one velocity will differ more than 30 f.s. from the average and somewhat more than half the velocities will be within 10 f.s. of the average. Such a variation will cause a mean vertical deviation of the projectiles at 2000 yards' range of 11 or 12 inches, for guns whose average initial velocity is 2400 f.s., and of 7 or 8 inches for guns having 2800 f.s. muzzle velocity.

The projectiles of any gun differ among themselves in shape and smoothness, but when they all have the same form of head and the various kinds are not of greatly different lengths, the resulting deviations are not so important as those caused by the variations in their weights. If we take the mean variation in weight to be 1% of the standard weight, the resulting mean vertical deviation at 2000 yards' range will be about 9 inches.

Neglecting the other numerous, but lesser, causes of deviation, and assuming that those described are independent of one another, we find the mean vertical and the mean lateral deviation which results from their combined action by taking the square root of the sum of the squares of the corresponding partial mean deviations.* And thus we have $\gamma_y=(15^2+7.5^2+9.5^2+9^2)^{\frac{1}{2}}=21\frac{1}{4}$ inches, and $\gamma_z=(15^2+7.5^2)^{\frac{1}{2}}=16\frac{3}{4}$ inches.

Of course the only correct way of determining the mean errors of a given gun is by actually firing a large number of rounds at a target and measuring the deviations, but the foregoing estimate will serve to give an idea of the errors to be expected in the case of modern guns of medium and large caliber. That the errors are very small under the favorable circumstances thus far considered is illustrated by figure 4, which represents a target made at Meppen on June 1, 1882, with a 28 cm. gun, the distance of the target from the gun being 2026 meters (2215 yards). The dotted cross is the mean point of impact, whose coordinates, referred to horizontal and vertical axes at the center of the target, are $z=32.4$ inches, and $y=-11.6$ inches. The mean lateral deviation is 9.5 inches, and the mean vertical deviation is 11.6 inches.

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* It is demonstrated in the Calculus of Probabilities that the mean value of the total error resulting from any number of independent causes is the square root of the sum of the squares of the mean partial errors.

The fact that these actual deviations are considerably less than our estimated ones may be plausibly ascribed to the fact that in Proving Ground firings greater care is taken in pointing the gun than is usually practicable under service conditions.

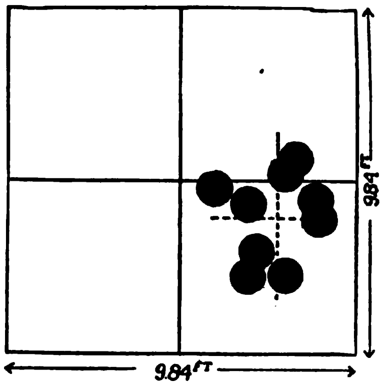


Fig. 4.

The Effect of Motion of the Gun Platform and Target.—The three angular motions of a ship's deck, caused by rolling, pitching and yawing, greatly increase the mean errors of naval guns, but their effects depend so much upon the skill of the gun pointer, as well as upon the state of the sea and the characteristics of the particular ship and gun mounting, that only the roughest estimate of their values can be made.

Most naval guns are mounted in broadside and only train from bow to quarter, and even guns mounted on the middle line are likely to be used most on the broadside ; thus the roll, which is the greatest and most rapid of a ship's angular motion, has its largest component in the plane of fire, and acts principally to increase the vertical deviations. The principal effect of pitching, on the other hand, is to increase the lateral deviations by causing the plane of the sights to be more or less inclined, now to one and now to the other side of the plane of fire. Motion in azimuth, mostly due to unsteady steering, affects the lateral deviations only.

If the target is in motion, the gun pointer must, of course, estimate its speed and direction in order to direct his fire at the point where the target will be when the projectile strikes, and his corrections must always vary in their accuracy from round to round, thus increasing both the lateral and the vertical deviations. Moreover, the changing direction of the target will cause the angle between the direction of the wind and the plane of fire to vary, thus necessitating a variable allowance for wind effect and again increasing the deviations of the projectiles.

Taking everything into account, probably a fair estimate of the mean vertical deviation of modern naval guns of medium and large caliber at 2000 yards' range, with skilled gun pointers, and under average conditions, would be 5 feet. The mean lateral deviation, which for guns on steady platforms is from two-thirds to three-fourths the mean vertical deviation, may be taken to be the same as the mean vertical error in the case of naval guns without any great error.

Both vertical and lateral deviations may be taken to be proportional to the range, at least up to 4000 or 5000 yards' range, though the former really increases somewhat more rapidly than the range.

Although the targets of naval guns are vertical, their fire must generally be regulated by observation of the points of fall on a horizontal plane. The lateral deviations are practically the same whether measured on the vertical plane (perpendicular to the plane of fire) or on the horizontal plane, but the deviations in range differ very greatly from the vertical deviations, the ratio between them being the cotangent of the angle of fall.

The Mean Deviation in Range.—Since the mean deviation in range (γ_x) is related to the mean vertical deviation (γ_y) by the formula $\gamma_x = \gamma_y \cot \omega$, and since the angle of fall increases (and its cotangent correspondingly decreases) with increase of range at about the same rate as the mean vertical deviation, it will be seen that the mean deviation in range remains nearly the same for widely different ranges. Thus, for example, while the estimated mean vertical deviation of the 12-inch gun of 2800 f.s. I.V. increases from 2.5 feet at 1000 yards' range to 10.5 feet at 4000 yards' range, the corresponding mean deviation in range only changes from 119 yards to 104 yards; and while in the case of smaller guns the mean deviation in range decreases more rapidly, still the change is always very much less proportionately than the change in range itself.

The principal use of knowledge of the mean deviation in range is in the regulation of gun-fire by observation of the points of fall.

Suppose the axis of **Z** in figure 5 represents the water line of the target, the axis of **X** being the trace of the plane of fire; and let the distances from *Z* to the dotted lines **aa, a'a', bb, b'b'**, etc., represent once, twice, etc., the mean deviation in range (γ_x) of the gun. Then if the mean point of impact is on *Z*, half of all the shots will fall short; if it is on **aa**, the percentage of shots which fall short will be increased by the number which fall between *Z* and **aa**, or, from the table of probabilities, it will be $50+\frac{57.5}{2}=77\%$; if the mean range is still further short, so that the mean point of impact falls on **bb**, the percentage of shorts will be $50+\frac{88.9}{2}=94\%$; and, finally, if the mean point of impact is three or more times the mean deviation short, then practically all the shot will fall short. The same reasoning shows that if no shot strike short of *Z*, the mean point of impact is

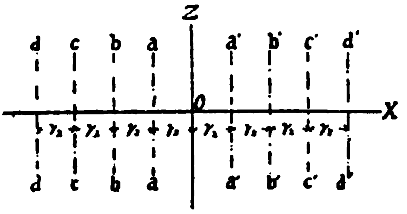


Fig. 5.

three or more times the mean deviation in range beyond *Z*; if about 6% strike short, the mean point of impact is about $2\gamma_x$ beyond *Z*; and if about 21% are short, it is about γ_x beyond *Z*.

Thus by observation of the percentage of shot which strike short it is possible to determine with some accuracy how much the sight bars should be raised or lowered to bring the mean point of impact on the target.

How closely the calculated percentage of hits agree with the results of experiment when the number of shots fired is considerable, is illustrated by the following table taken from Hélie's well known Traité de Balistique. It represents about 500 shots fired at Gavre from the 16.5 cm. rifle at various angles of elevation.

Probability that the lateral deviation will not exceed

	$\frac{\gamma_z}{4}$	$\frac{\gamma_z}{2}$	γ_z	$2\gamma_z$	$3\gamma_z$
By table	0.158	0.310	0.575	0.889	0.983
By experience	0.176	0.300	0.592	0.885	0.988

THE NEW BOAT TELEPHONE SET.

By Captain H. G. BISHOP, Artillery Corps.

This telephone set was designed by Captain C. F. Parker, Artillery Corps, Chief of the Electrician Sergeant's Division at the School of Submarine Defense, for communication between the mining casemate and the detail at work on the water, planting submarine mines or testing a system of mines already down. Upon recommendation of the Torpedo Board the set has been adopted by the Chief of Artillery and will soon be ready for issue to posts supplied with a submarine mine equipment, replacing the present type of boat telephone which has been in service some time and which is heavy, complicated and unsatisfactory.

This set has been designed with a view to simplicity, lightness and to withstand hard usage, and is practically water-proof.

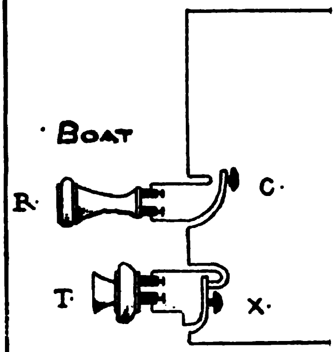
Two telephones (interchangeable), one interrupter (buzzer), and an earth plate constitute a set. When set up the system will consist (see figure) of one telephone, interrupter and battery on shore and one telephone in the boat connected in series through the core of a submarine cable, the circuit being completed through earth. Either storage battery or primary cells, wet or dry, can be used.

When not in use the current is through both receivers, the transmitters being shunted out. To call, the operator presses the call (black) button, this shunts out the caller's receiver and the lessened resistance causes the interrupter to vibrate, giving a loud buzzing in the other receiver. To cut in the transmitter, the transmitter (white) button is pressed and the current is through it, both receivers and the interrupter.

The transmitter will be of the granular type, of solid black construction.

The receiver is to be of the watch case pattern, the receiver and transmitter being connected by a rigid handle, of such shape that when the receiver is held to the ear the transmitter is convenient to the mouth. The call and transmitter buttons are located in this handle, the transmitter button being so located that it is pressed inward and the transmitter circuit cut in by the

Circ



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ordinary grasp of the hand in holding the instrument to the ear. A flexible silk cord about six feet long is permanently attached to the back of the transmitter for connecting the instrument to the line.

Each telephone is provided with a case of heavy, oak tanned, fair leather, hand sewed throughout, with leather-hinged cover, the inside being stuffed to fit the shape of the telephone, with strap for slinging attached.

It will be noted that this phone is on a closed circuit, but it should be emphasized that the instrument is not designed, nor would it ever be required for long continued use, being set up only when the boats are on the water laying and connecting cables or testing cables already down, for a few hours at the very most, at any one time. With a charged storage battery or fresh dry cells the circuit would not be weakened during the short time a set would be in use. The advantage of the closed circuit is that it obviates the use in a small and unsteady boat of a magneto box and bell whose action may be seriously impaired by a dash of water, or by being dropped in the boat.

A PROPOSED AUTOMATIC SIGHT FOR DISAPPEARING GUNS.

By Captain WILLIAM C. DAVIS, Artillery Corps.

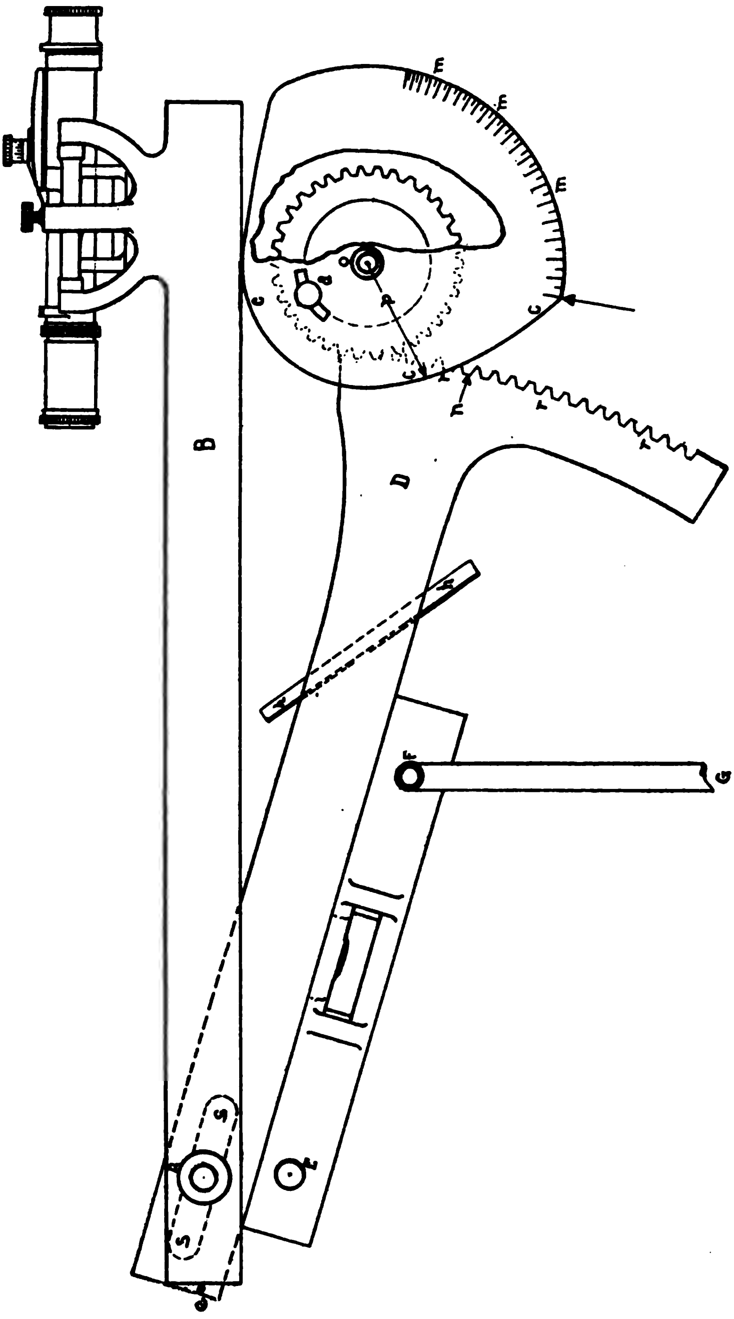
Readers of the JOURNAL will remember that on the 6-inch disappearing carriage as well as upon the latest model of the 12-inch disappearing carriage, there is an auxiliary arm, intended to carry the telescopic sight for firing in Case I. This arm is so connected with the elevating mechanism of the carriage as to be constantly parallel with the position the axis of the gun would occupy "in battery." In the case of the 12-inch gun, the gunner elevates and traverses the gun by means of electric motors; the movements of the 6-inch he regulates by suitable handwheels directly connected with the elevating and traversing gears.

In the sketch **E F**, pivoted at **E**, represents the auxiliary arm which is always parallel to the axis of the gun in battery. Take off the sight bracket and in its place firmly attach to **E F** the arm **A D**, carrying the rack **r r r**, whose center is **E.** This rack meshes with a spur wheel, centered at **O**, on an axle borne by a bracket secured to the sight standard or to the chassis. The cam **c c c** is secured to the spur wheel by a clamp screw, **a**, which permits of a slight motion for adjustment. As the spur wheel turns, due to the motion of **E F**, the arm **A B**, pivoted at **A** and carrying the service telescopic sight, rides upon the cam **c c c.** The cam is so cut that for any angle of elevation of **E F**, corresponding to any given range from the gun, the line of sight through the telescope will intersect the surface of the water at the same range. Therefore, if the gunner keeps the target constantly waterlined, the gun must continually have the necessary elevation for the successive positions of the target.

The cut represents the sight when the gun has its maximum elevation.

Adjustments for height of tide and for abnormal refraction are made by means of the slot, **s s**, and the elevating screw of the telescopic sight, respectively; or the sight can be adjusted on two datum points, as in the case of the D. P. F.

Correction for drift is made by means of an inclined rib against


E
E
E
C
C
C
P
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D
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S

which the arm **A B** slides in its up and down motion.

Correction for unlevel gun platform is made by means of the level **i i**, in conjunction with a slight shifting of the cam, **c c c**.

Ranges to the target can be read off on the graduated limb **m m m**.

The cam **c c c** is cut for the standard velocity of the gun ; for a sub-caliber tube, or for a velocity differing materially from the normal, a new cam is necessary. Corrections for slight changes in the M. V. can be made by shifting the cam slightly on its center.

For ranges less than 1200 yards or thereabouts, within which it is thought that a gunner could hardly maintain his position against the fire from ships' secondary batteries, a reflecting sight is provided. This sight consists of a mirror, **h h**, with an unsilvered cross intersecting in the center, attached to the farther end of the arm **A D**, and a stud, **e**, as front sight, projecting from the same arm. The method of employment is obvious.

An experimental sight, conforming to the general design above described, is about to be constructed and tested by the Ordnance Department.

While this device is primarily intended to apply to disappearing guns, it can, with slight modifications, also be applied to barbette mounts.

Whatever their opinions as to the relative merits of Case II. and Case III., coast artillerymen generally will concede the great benefits that should be derived from an automatic sight on a gun favorably located for its use. Even at ordinary drill the system of communications frequently breaks down without warning; telephones refuse to work, and telautographs decline to "tell aught." Those who have witnessed the joint maneuvers must have wondered how long a B. C. station would continue in action under the tremendous fire of a squadron, and what the effect upon the nervous system of the men working therein would be during a bombardment or a run-by. But after the B. C. station goes out of commission, from whatever cause, then the fight must be continued from the guns themselves, and it is right here that the automatic sight should prove its usefulness.

PRESENT STATE OF FIELD ARTILLERY REARMAMENT.

Ever since France led the way by adopting her original and highly efficient rapid-fire field material, other nations have been deeply interested in the important question of field artillery rearmament. Since the adoption of the French gun in 1897 constructors elsewhere have succeeded in solving the mechanical difficulties at first thought impracticable of solution and many experiments towards improving the design of the long recoil rapid-fire gun have been made, so that it has now been proved that a true rapid-fire field gun can be obtained. Discussion of the merits of the various systems that have been developed and numerous competitive tests of different models have been thorough and searching. As a result, a number of the principal Powers have definitely decided on a new material with gun recoiling on the carriage. Several others are yet conducting trials looking toward the selection of the most satisfactory type in the near future, and only a few have not yet come to any decision in regard to their field artillery. In the following lines endeavor is made to give a review of the present status of the field artillery question in all the various countries.

ENGLAND.

At present England has 18 batteries of Ehrhardt rapid-fire guns. These guns are of 3-inch calibre, firing a projectile weighing 14 pounds 15 ounces. The carriage has a hydraulic buffer with spring recuperators for returning the piece in battery, and a telescopic trail.

But beginning before the South African war and continuing after it, England has experimented for years with types of rapid-fire field guns, and has now chosen and adopted a long recoil gun which combines the best qualities of recent designs by Armstrong and Vickers, and is much superior to the former 15-pounder. According to recent reports it is said the manufacture of both the new field gun and the horse artillery gun will begin in April, and it is hoped to complete 108 field guns and 18 horse artillery guns in the year.

The projectile for the new field gun weighs 18½ pounds, and that for the lighter gun, 12½ pounds. The carriage will have shields and it is understood that the double-laying system has also been adopted, but details as to the proposed sights are not yet obtainable.

GERMANY.

Germany also inclines to the new long recoil system. Although the Minister of War, no doubt from political reasons, maintains his opinion before the Reichstag of the superiority of the German elastic trail-spade type over the French long recoil, Germany, nevertheless, continues the process of transformation or suppression of the model 1896. The situation is somewhat embarrassing. The necessity for rearmament is appreciated and desired, but such haste was made in adopting the model 1896 material with elastic trail-spade that financial considerations prevent Germany from undertaking at present a completely new rearmament of the field artillery however necessary it may appear.

The result is that trials are now going on to change the field guns, model 1896, into long recoil guns by an adaptation of recoïl on the carriage to the present gun, that is to say, while keeping the gun itself, a carriage has been designed with a cradle for the piece. The carriage has also been fitted with protective shields. The guns thus modified do not possess the double-laying arrangement applied to the cradle or top carriage. The gun itself retains the rear sight and foresight, and the changes that have been made affect principally the carriage.

According to the German press, the results have been satisfactory both in regard to action during firing and in maneuvering facilities. In spite of the added weight of the shields, the total weight does not exceed the usual limits. Nothing is known in regard to the caissons, whether they are to be armored or not. Thirty-six of these altered guns are in the hands of troops, attached in part to the Guard at Berlin, three batteries, and in part to the Field Artillery Shooting School at Juterbog. Five batteries have taken part in last autumn's maneuvers and have given satisfaction.

In addition to the foregoing, Germany is also engaged in conducting trials of new long recoil types. The Ehrhardt new model, 1899, has been found inadequate and Krupp's model, 1900, has proved better. Two of these guns were tested in 1902 by an artillery commission and resulted in orders being given for seven trial batteries, which were thoroughly proved under service conditions in 1903 and were found to be very satisfactory, but the design was modified slightly and submitted for further test. The last proof trials of the new rapid-fire gun, which were held recently at the Krupp firing grounds near Essen, were so satisfactory in all respects that it seems assured that the Krupp model will be definitely adopted. The gun and carriage functioned well in every test on the proving ground, and now only the results of the endurance tests over heavy country are awaited. These were to be held in the Harz during several weeks in November and December, 1903, under the direction of a battery of the Field Artillery Shooting School.

The Krupp gun chosen is similar in all particulars to that adopted by the Swiss, and like that model constitutes one of the best of the recently constructed rapid-fire systems.

It is to be noted, however, that the budget for 1904 makes no appropriation for the rearmament of the field artillery.

AUSTRIA.

After seven years' of experiments and trials, renewed time after time, the announcement is made that a definite decision will be reached in the spring of 1904. The long recoil system has been adopted on principle, but the special model has not yet been decided upon. Numerous types have been submitted by various gun factories and have been experimented with; among others, those by Ehrhardt and Skoda. Some batteries of these guns and carriages are at present in the hands of the troops.

Independently of the question of the carriage, that of the metal to be used for the gun itself was for a long time the subject of discussion. It appears that the bronze piece weighs 25 kilograms more than one of steel, but after full consideration the forged bronze, for which the Austrian factories are noted, has, as was to be expected, been selected for the material of the new guns.

The type of the carriage and whether the caisson is to be armored are the two questions that have not yet been defidefinitely decided. As for the gun, it will be of 75 mm. calibre, with long recoil on the carriage, and will be provided with shields with hinged portions. It will have the interrupted-screw fermeture, and the laying apparatus will be similar to that of the guns now in service. With regard to the carriage, very complete tests have been held with telescopic-trail carriages, system Ehrhardt-Mannesmann, and with carriages of the Skoda system. Both of the models have been modified and improved in the course of the experiments.

It is anticipated that the question of armoring the caissons will also be soon decided. Reports indicate that the Austrian

War Department, adopting the idea that in battle the caissons will be under cover in rear of the line of pieces in battery, will give up the idea of introducing armored caissons.

FRANCE.

The French field batteries have been armed with the new 75 mm. rapid-fire material since 1897. This is a long recoil field gun with protective shields and was manufactured with great secrecy in the government workshops at Brouges according to the plans and design of Colonel Deport. The secret of the details of construction is not yet entirely divulged, although this material has been written about probably more than any other. All the literature relating to the subject indicates that many of its characteristics and ballistic properties are still not known exactly. Even the data on the total weight of the piece, etc., are still variable, and it is to be noticed that French official publications contain, no doubt intentionally, false indications on this point.

But it is known that this gun possesses great ballistic power, and that its projectiles weighs somewhat more than those of similar guns constructed elsewhere. Its only disadvantage appears to be the weight of gun and carriage, which is a little high if we accept as correct the weight generally given. Criticism has also been made of the shields used, as presenting rather a reduced amount of surface for the protection of the cannoneers.

The choice yet remains to be made in France of a light rapid-fire gun suitable for the horse artillery. It is said the pneumatic recuperator is to be given up for this gun.

ITALY.

The field gun question in Italy has long been a subject of controversy. Discussion of the question of the proper type of new material has been vigorously conducted on both sides by critics and leading military writers, but the Italian army, it seems, is the one that has remained for the longest time averse to the idea of a field gun with long recoil on the carriage.

As is known, the Italian field artillery consisted of two calibres of guns, the 87 mm. B, of steel, forming the armament of the larger part of the batteries, and the 75 mm. B, of bronze. In 1896 and 1897 when France and Germany effected the transformation of their field material a partial transformation was decided upon in Italy. For the material 87 mm. B, the cast-iron shrapnel was retained, and the changes made were confined to limiting the recoil of the piece by the addition of a trail spade, and to increasing the rapidity of loading by improvements in the breech mechanism.

The lighter field pieces, 75 mm. B, of bronze, were, however, even at that time out of date. Hence it was necessary to replace them completely by more modern material. Two years or more were devoted to full consideration of the queston, and, finally, the present gun was decided upon. This gun is of steel, of 75 mm. calibre, and has the interrupted-screw fermeture. The metallic cartridge case is separate from the projectile. The gun is mounted on a short recoil carriage with elastic trail and folding spade, and there are no shields. In fact, with the exceptions noted, the design is very similar to the German gun model, 1896, and comes within the class designated "accelerated fire." The short recoil carriage does not completely answer all tactical requirements now recognized as necessary in the true rapid-fire field gun.

At the time of adoption of this material, 75 mm. A, the long recoil carriage did not seem to present sufficient guaranty of being practicable, and the rearmament of the batteries had already commenced, when due to the great technical advance made by the leading factories, the problems of the long recoil carriage were satisfactorily solved, and Krupp, Ehrhardt, Schneider-Canet, Vickers and others proved the practicability and advantages of such a carriage. But the transformation of the material, 75 mm. B, having been begun it became necessary to continue it. Italy has committed, then, the same error as Germany, at least for its light field material, although this rearmament has been much more recent. There have been many difficulties with the delivery by Italian workshops, but nearly 540 guns of this new material have been completed, and the last batteries of these guns have been delivered to troops hardly six months ago. Hence it is hard to acknowledge already that a mistake has been made.

In the meantime, the long recoil system has come into favor there as elsewhere. Trials with long recoil guns are going on, and the question of the transformation of the heavy material, 87 mm. B, has not been suspended any the less. At the arsenal at Turin studies and trials are being pursued with the object of either modifying the latest carriage so that it might be furnished with a cradle designed to receive the gun, or else designing an entirely modern carriage. In either case the recoil system will be analogous to that of the Krupp model, 1901, with spring recuperator. These trials have not yet been concluded.

Whether the caissons will be armored or not is a question that still awaits decision.

While awaiting the termination of these experiments, the manufacture of the new carriages is not being hastened, but that of the guns is being actively pushed. The material, 75 mm. A, that is at present constructed replaces only the old equipment of bronze, and it is probable that the rest of the Italian artillery will not be armed with the same gun.

SPAIN.

Spain after prolonged trials ordered three years ago from St. Chamond and from Krupp 120 guns of a transition type. The carriages are equipped with hydraulic brakes, have a trail spade, and there are spring recuperators under the body of the carriage, This material was delivered about two years ago. At about the same time 24 field pieces with long recoil on the carriage were ordered from Creusot, which were accepted only after much delay due to the failure of the material to meet the requirements of the Spanish artillery. Recently the Spanish government opened a new competition for guns with long recoil on the carriage, but it seems that no decision has been arrived at as to the type to be adopted for the field artillery. It is reported that the idea of experimenting at home has been given up, and a special board of information has been sent to France, England and Germany.

PORTUGAL.

The only modern field artillery Portugal possesses are two horse batteries having guns with elastic trail-spade carriages. The government sent a special commission some time ago to different countries to gather information from the prominent gun makers. This commission has now returned and submitted its report, on the strength of which it has been decided to make conclusive trials in Portugal with some proposed constructions by Krupp and Schneider.

RUSSIA.

After protracted experiments Russia has provisionally chosen for the field artillery a type of gun and carriage designed by General Engelhart. A large part of the Russian field artillery, 1200 pieces, it is said, has been armed with this new gun constructed at the Poutilov works. The gun, together with the cradle that supports it, recoils on the lower carriage, and the recoil is controlled by a glycerine brake (generally so stated, or a hydraulic brake, according to others) and a column of rubber buffers fitted in the trail. These rubber cushions act as return springs to return the gun in battery.

This model, however, has not been selected definitely, and, it is not certain that the Engelhart gun is to be issued to all the field batteries. It rather seems that an improved and more perfected type will be adopted for the balance of the Russian artillery.

This gun is of great ballistic power but the same objection is raised against it as in the case of the French and Norwegian material, its great weight. Nor is the carriage provided with shields. Whether the caissons are to be armored is not known, though the regulations prescribe placing them beside the pieces in action.

NORWAY.

In Norway the new field gun tests were concluded in 1901. The government experimented with models of long recoil guns from Armstrong, Hotchkiss, Nordenfelt-Cockerill, St. Chamond, Schneider-le-Creusot, and Ehrhardt and finally gave preference to the last named. The program of the tests was very thorough and severe. It included firing 350 rounds from each gun, transportation over long distances both by rail and in ordinary carts over mountainous country, in which the material received much rough treatment, more firing tests and finally a long march over difficult country and under varied conditions. The final firing showed that the material was in good condition, all the parts functioned well, and the hydro-pneumatic brake was in perfect condition.

Norway has obtained 132 guns of the Ehrhardt system and 72 caissons. As in the case of France the adopted gun has the disadvantage of being rather heavy, 2,209 pounds, without any shields. The question of shields has only been considered after the guns were ordered, so that its weight makes the problem of providing it with shields a difficult one.

SWEDEN.

When trials began in Sweden, Cockerill and Krupp were the only competitors. The two French firms, Schneider and St. Chamond, found if impossible to fill the specifications as to the weight of the unlimbered gun. The Krupp long recoil material was adopted for the field artillery, and Sweden has ordered 132 guns and 66 caissons from Essen. For the horse artillery the Krupp short recoil material was chosen, and 24 guns with elastic trail-spade have been bought from the Krupp works.

DENMARK.

In Denmark the trials began in 1901 about the time those in Norway were being concluded. Schneider-le-Creusot, Krupp, Ehrhardt and Cockerill, submitted models for test. A decision was reached in October, 1902, and the type adopted was the Krupp long recoil gun. An order was given then for 128 guns and 192 caissons, which are to be delivered by April 1st, 1904.

This gun is of 75 mm. calibre and shields with hinged portions are attached to the carriage. The shrapnel weighs 14.4 lbs. (6.56 kg.) and contains 300 bullets of 11 grms. each. The muzzle velocity is 1640 f.s.

The weight of gun with carriage is 2165 lbs., and together with limber, including complete equipment and 44 rounds carried, is 3875 lbs. The caissons are armored.

The ammunition will be manufactured in Denmark.

NETHERLANDS.

The present field artillery dates from the year 1878, so that it no longer fulfils the ballistic and other technical requirements of the present day. The necessity of replacing it has been recognized, and in 1901 this subject was taken under consideration. Now after two years' experiments and trials in which models from Ehrhardt, Schneider-le-Creusot and Krupp were entered, the decision has been reached that Krupp's 75 mm. long recoil gun deserved the preference, and was to be recommended for adoption. There was some discussion by Ehrhardt on the result of the competition but the government of the Netherlands adhered to the recommendations of the military commission, and the Minister of War brought in a bill, accordingly, for the complete rearmament of the field artlllery with long recoil guns after Krupp's design. This bill has been passed by both Houses of the Dutch Parliament and a contract has ben made with Krupp for 204 field guns of this type.

Krupp is to furnish all the guns with their carriages, 57 limbers and 162 caissons, ⅓ of the required amount of shrapnel and all the combination fuzes. 147 limbers, 246 caissons (200 for the artillery park) all the battery wagons and accessories of the train, the rest of the ammunition and fuzes, horse equipment, etc., are to be manufactured by the arsenals and private firms at home, the total cost amounting to seven million guilders. 425,400 guilders are asked for this year, in the main to pay for a complete battery for practice and instruction of the personnel at the proving grounds at Olderbroek.

The adopted type is the Krupp nickel-steel field gun with long recoil on the carriage; its calibre is 75 mm., length 30 calibres, and it is provided with nickel steel shields 3 to 4 mm. thick. It fires shrapnel and explosive shell weighing 13.2 lbs (6 kg.). Fixed ammunition is used.

The muzzle velocity is 1640 f.s., rapidity of fire 20 shots per minute. The shrapnel contain 270 bullets, each weighing 11 grams. The extreme range is 7,000 yards, and that for shrapnel with time fuze 6,125 yards. The unlimbered gun weighs with shields and complete equipment not quite 2,200 pounds; the gun and carriage together with limber completely equipped weigh in round numbers 4,000 pounds.

Each limber carries 40 rounds; each caisson body 64 rounds; and caisson with limber for the train, 88 rounds; so that each gun with its limber and 3 caissons can count on 336 rounds. The caissons are armored with nickel-steel plates 3 to 4 mm. thick.

The introduction of this material will be completed by December 31, 1906.

BELGIUM.

Belguim experiences much difficulty in reaching a decision. From year to year there has been delay, but at present some very thorough competitive tests are being conducted and it would seem that a solution of the question will be reached in the near future. These tests now being held at the proving grounds at Brasschaet were begun last September and the greatest secrecy prevails in regard thereto. Long recoil models were submitted by Cockerill-Nordenfelt, Ehrhardt, Krupp, St. Chamond and Skoda. Cockerill has also entered one gun of a rigid carriage design from a battery that has been in service three years in the 3rd regiment of artillery, but there is little expectation of this gun being adopted. Various accidents have marked the course of the trials, causing delay and in some cases rendering repairs necessary. It is anticipated, however, that they will soon be completed.

Though the majority of the Board has declared for the long recoil system, it remains doubtful which of the competing designs will be selected.

SWITZERLAND.

The Swiss trials were the most exhaustive of all. Nearly all the leading gun factories of Europe competed and Cockerill, Ehrhardt, Krupp, Schneider and Skoda furnished their latest models. St. Chamond accepted the invitation to compete, but did not deliver its gun in time and did not participate in the trials. Later on this gun was inspected at St. Chamond but without result. In fact, the artillery commission on field artillery rearment has during the last six years submitted all the models that it has been able to procure and experiment with, to most searching examination and most thorough tests under all conditions. The final trials commenced in 1901, and in March 1903 the commision submitted its report declaring that the Krupp 75 mm. long recoil model was not only the most satisfactory in all respects and the best of all the models tested, but that it was the best adapted for service in the field.

The Federal Council addressed a message to the Federal Assembly on May 1st, 1903, deciding on the adoption of the new gun, and in that year the Swiss goverment ordered from Krupp 288 guns, with which it is proposed to arm 72 batteries of 4 pieces each. This does not include reserve material and that for instruction purposes.

The material adopted, officially designated "field artillery matenial, 1903", is Krupp's latest design of long recoil field gun with spring recuperator and shields. The question of the exact dimensions of the shield is deferred for the time being ; the size may be reduced and the side wings dispensed with. It was decided by the commission to armor the caisson bodies. Fixed ammunition is used. The larger part will consist of shrapnel with combination fuzes, that being considered the principal projectile, but the batteries will also be provided with explosive shell with percussion fuzes. All projectiles will have the same weight. The ammunition supply will be 800 rounds per gun.

Krupp it to furnish only the guns and carriages ; all the rest of the material, wheels, caissons, limbers, ammunition, battery wagons, etc., will be manufactured in Switzerland.

The principal characteristics of this new material are as follows :

Calibre	75 mm.
Length of the piece	30 cal.
Weight of piece with breech mechanism	720 lbs.
Height of trunnions	38.97 inches.
Track	55.12 inches.
Diameter of wheels	51.18 inches.
Weight of the carriage with accessories (with shields 3 mm. thick)	1378 lbs.
Weight of piece in battery	2098 lbs.
Weight of limber	1764 lbs.
rounds carried	40.

Weight of gun limbered, with equipment	3862 lbs.
Weight of shrapnel and shell	14 lbs. (6.35kg.)
Muzzle velocity	1590 f.s.
Weight of caisson	4012 lbs.
rounds carried	90-100.

This rearmament is to be completed by the spring of 1906.

The commission also studied the question of field howitzers, making trials of different models submitted by Krupp and Skoda, and decided in favor of one of 12 cm. calibre, but the particular model is still to be selected. The commission was of the opinion that the introduction of a howitzer for the Swiss artillery should not be made at the price of reducing the number of field guns. It estimated that there was necessity for the purchase of 8 batteries of 4 pieces each, constituting 4 groups of 2 batteries. For the howitzers, the ammunition supply will be 500 rounds per gun.

In regard to mountain guns, the commission has conducted several tests of a Krupp gun of a system similar to that of the field material, 1903. Although the results obtained thus far have been satisfactory, it has been thought best to continue the experiments with two pieces in which certain modifications of of details have been. Hence the question is not yet definitely settled.

GREECE AND BULGARIA.

For financial reasons Bulgaria and Greece have not made any decision as regards the rearmament of their field artillery, and it is not known whether they contemplate taking any steps as yet towards doing so, at least nothing of that nature has been published.

TURKEY.

Without having any trials at home, Turkey has ordered from the Krupp works 184 guns with which it is intended to equip 16 batteries of 6 pieces each, and 22 batteries of 4 pieces. These guns are of the modern long recoil system. The order included all accessories, caissons, battery wagons, ammunition and harness. Recently the foreign press announces that the government is urging the delivery of the first six batteries constructed.

Turkey has in the past sent several delegations to Essen and on two occasions also to other workshops. It is announced now that a military commission of prominent artillery officers of the Sultan's army is now in France visiting the establishments of Creusot and St. Chamond in order to study the most recent models of long recoil rapid-fire field guns. Some firing trials are to be held at the proving grounds at Havre in the presence of this commission, preliminary to the probable ordering of new field material, with which duty the commission is charged.

SERVIA.

Up to the present time, the trials contemplated in Servia have been only with a battery of Skoda guns. They were being begun at the time of the assasination of King Alexander. Since then, it is stated that they will be resumed and at the same time some other models, not yet fully designed, will be entered.

ROUMANIA.

The first competitive tests with modern rapid-fire material were held in 1898-99. St. Chamond, Krupp, Schneider, Creusot and Hothckiss submitted models for trial. There was also one model with a Darmancier carriage presented by Colonel Peticari of the Roumanian army. In 1900 the trials were interrupted and later taken up again. At the present time, the new tests are being pursued with a battery of Krupp long recoil guns of recent design.

CHINA.

In China it is not to be expected that the question of field or mountain artillery will receive attention, for the present at any rate. The viceroys and governors of the various provinces will continue as heretofore to purchase guns here and there, in large and small quantities, without regard to anything but their personal fancy.

Japan seems very well satisfied with their Arisaca gun, and nothing has appeared of any steps being taken towards the introduction of a new material.

MEXICO.

Mexico has carried out long competitive trials and at their conclusion, after having ordered four batteries of guns from Creusot in 1902, asked St. Chamond in 1903 to submit a model of the St. Chamond-Mondragon type modified according to the desires of the Mexican Commision. If this type is found satisfactory, 8 batteries of them are to be ordered.

UNITED STATES.

It seems unnecessary to enter into details. The full report of the competitive tests held and the description of the models entered, is given in the Report of the Chief of Ordnance for 1902, and the new adopted material has recently been described in the JOURNAL. It is understood that a battery of the new guns is now at Sandy Hook for the final proof firing.

BRAZIL.

In Brazil competitive trials were held in 1902 between the Krupp and Creusot types, and according to Brazilian reports these tests have demonstrated the superiority of the German model.

The new administration, however, which came in in the latter part of 1902, desired to make further trials of other types recoiling on the carriage, in which Creusot, Krupp, Vickers, and Ehrhardt would compete. A decision has not yet been reached as to the type to be adopted.

ARGENTINE.

The Argentine Republic possesses at present a new light field gun with elastic trail-spade. This piece is well adapted to the local conditions of the country, and is a good service gun. For financial reasons also, the government is not thinking of replacing it by a more modern class of ordnance.

CHILI.

Chili also seems content with its present field artillery material. This is a light field gun of the Krupp system with elastic trail-spade, and is well adapted to the local conditions of the country.

The present situation is, then, as follows: Of the nineteen European States, nine have definitely decided on, and have adopted the long recoil system. These are England, France, Spain, Norway, Sweden, Denmark, Netherlands, Switzerland and Turkey. Of the nine, only France and Norway have their field artillery wholly of the new type. In the seven others, the process of rearmament is in progress, or is to begin at some future date more or less distant.

One government, Russia, has adopted for a part of its field artillery a special model with long recoil.

Seven States are still conducting trials: Germany, Austria, Italy, Portugal, Belgium, Roumania, and Servia. Two States, Bulgaria and Greece, do not appear to have taken up the question.

Of the other countries mentioned, only one, the United States, has concluded its trials and adopted the new long recoil system in line with advanced continental ideas on this subject.

PROFESSIONAL NOTES.

A Modified Time-Range-Relation Board.

BY CAPTAIN HENRY J. HATCH, ARTILLERY CORPS.

In his report on the tests of an experimental system of fire control and direction in Pensacola Harbor, the Chief of Artillery describes an installation which he recommends as applicable to all sites. The system of fire control and direction requiring this installation has been recommended by the Board of Ordnance and Fortification and the proceedings of the Board approved by the Secretary of War.

Paragraph 14 of the report of the Chief of Artillery under the head of "The Installation" reads as follows:

"To provide for the continuous plot of the time-range and time-azimuth relations in each gun emplacement, and at the battery commander's station, charts prepared at post either on cross-section paper or on ruled blackboards shall be provided, the material to be furnished by the Ordnance Department".

It is understood that these charts are the auxiliaries to the system of fire direction developed at Fort Monroe, Va., referred to by the Chief of Artillery in a previous paragraph of his report in which he describes the characteristic feature of this system as one which permits the decision as to the particular instant at which a gun is to be fired, to be made at the gun and is independent of the particular instant of time when observations are taken, or for which prediction is made. As these charts or indicator boards are apparently to become a part of our system, the method of constructing them become a matter of interest to artillerymen.

A modification of the board used at Fort Monroe has been in use for about three months by the 15th Company, Coast Artillery, stationed at .Fort Barrancas, Florida, and it has been found to possess such manifest advantages that a description of it is submitted for the consideration of the readers of the JOURNAL. The modification consists of an arrangement of the information on the board in such a manner that the range to the target (or corresponding elevation) at a time later than the time selected for firing, by an amount equal to the time of flight, is read directly from the board, the travel in range of the target during the time of flight being automatically provided for. This arrangement simplifies the work of laying the gun in that it obviates the necessity of locating a set-forward point on the plotting board or of any consideration of the time of flight, by the gun commander.

If, in addition to this arrangement of the indicator board, the plotting board is provided with range circles with the directing gun as a center, or other rapid method of determining the relocated range, and range corrections are applied as determined from Pratt's ballastic board, or similar device, the range information for any gun can be delivered to its emplacement within 15 seconds of the time of observation. If observations are made every 20 seconds and a prediction made on each observation, the predicting interval may be reduced to one minute, and yet have information at the guns always more than 25 seconds in advance of "Present Time." The advantage of reducing the predicting interval to one minute is obvious. This time of flight feature of the indicator or time-range relation board does not in any manner decrease the simplicity of its construction or operation. This feature may be retained and the details of construction varied to suit the fancy of the operator.

Two methods of construction which have been found to work satisfactorily will be described.

First select a well-seasoned soft wood board 6 to 8 feet long by 12 to 14 inches broad and cover one side with sheet zinc. Next take an ordinary foot rule, erase the numbering of the graduations and substitute new ones, letting the smallest division represent one second of time. Mark a graduation about 2 or 3 inches from the right hand end of the scale "60," the second one to its left "58" and so on down to "0," the second one to the left of 0, "58" and continue about 20 seconds further, or to "40".

Next take a strip of 10 to the inch cross-section paper as long as the board and about 12 inches wide, and select four lines running lengthwise of the paper which are 20 seconds apart according to the time scale just constructed. For the purposes of this description, these lines will be referred to as **A**, **B**, **C**, **D**, from left to right. The **A** line should be about 2 inches from the left hand edge of the board at the nearest point, when adjusted. If the time scale has but 8 divisions to the inch these 20 second lines will be 2½ inches apart, and it would be well to mark them over with a lead pencil for purposes of identification. Beginning near the top of the paper with the maximum range, say 12000 yards, and with a scale of 1 inch equals 100 yards, write down the ranges every 500 yards in a column about one inch to the left of the **A** line.

Opposite each 500 yard range lay off a distance to the right of the **D** line equal to the time of flight for the range and standard velocity. Mark the points so found. A line drawn through these points may be referred to as the time of flight curve and will vary only slightly from a straight line. A straight line may be drawn so that it will not miss any of these plotted points by more than ½ or ¼ of a second according to the time scale.

This error is not material.

Now lay the cross section paper down on the zinc covered board and so adjust it that this line will be parallel to the right hand edge of the board, and fasten the paper temporarily.

With a fine punch, punch a hole through the paper and zinc, every 10 or 20 yards along each of the **A**, **B**, **C** and **D**, lines and, for the purposes of identification, at every 500 yard division. Now remove the cross-section paper and with an awl or other sharp pointed instrument draw range lines across the board every 100 yards and use pen and ink or number dies, such as are used for stamping azimuth circles, to mark each. If the elevation disks on the gun carriages are graduated in degrees and minutes instead of yards, it will be necessary to mark the elevations every 20 yards, which can be done most conveniently by attaching to the board a strip of cross-section paper one inch wide, on which are written the proper quadrant elevations for each 20 yard interval. Several such strips for velocities other than the standard velocity may be kept on hand, if desired. The elevation strip should be to the right of and parallel to the **D** line of holes. The board is now ready for use. The time scale may now be laid on the board against any of the range lines so that the zero of the scale is to the right of the **A** line an amount equal to the time of flight for the particular range and a cross head attached so that when the cross head is against the right hand edge of the board, the fiducial edge of the time scale is parallel to the range lines, and as the scale is moved up or down the zero will always be to the right of the **A** line of holes, an amount equal to the time of flight. In the operation of the board, two long pins with large heads will be found convenient.

As a range and its corresponding time is received at the emplacement, a pin is stuck in the proper hole, and lines drawn on the zinc surface connecting the successive pin positions will represent the time-range curve. If information is slow coming in, these lines may be prolonged a short distance without material error. In fact, it is possible to do all the predicting on this board in this manner with reasonable accuracy, merely the observed ranges of the target every 20 seconds being sent to the gun.

When a pin is placed in a hole in the **D** line another pin should be placed in the hole representing the same range in the **A** line. In this manner the time-range curve can be continued for the following minute. When the instant that the gun will be ready to fire has been determined by the time keeper or chief of elevating detail, he notifies the operator of the indicator board, who notes the proper division on the time scale, and with the cross head held against the right hand edge of the board, moves the scale up or down until the time-range curve passes under the time-scale at the selected division. The proper range or elevation of the target for the time at which the projectile will reach the point of impact may then be read off at once. In place of the zinc covering, the board may be painted with several coats of lithite water-proof paint and small brass-headed brads driven every 20 yards along the 20 second lines. If the lithite paint is available this method will probably be found to be preferable. However, both of these methods are simple of construction and easy of operation.

It is probable that cross-section paper covered with celluloid would be still better.

If it is not thought desirable to reduce the predicting interval, a strip of plain paper of proper width according to the time-scale, may be attached to the board and renewed from time to time. In this case the 20 second lines may be omitted altogether, the time-scale made 5 or 10 minutes long (the smallest division being 5 seconds) and fitted with a cross head at each end. The left hand cross head should be adjusted at right angles to the edge of the time-scale, and the right hand cross head should make an angle with the edge of the time-scale equal to that made by the time of flight curve with the range lines. The distance between these cross heads measured along the fiducial edge of the time-scale should be greater than the width of the board at any range line by an amount equal to the time of flight for that range, the right hand edge of the board being planed down to the time of flight curve. The left hand cross head is held against the left edge of the board in plotting the time-range curve and the right hand cross head against the right hand edge of the board in selecting the proper range or elevation for firing.

This construction is rapid and easy of operation, but is not so well adapted for use with one minute predicting intervals as the others. The same principles of construction and operation would, of course, apply to a board for plotting the time-azimuth relation when Case III. is used.

Artillery Practice.

The following interesting memorandum prepared by General Story, Chief of Artillery, under date of March 8 and addressed to Gen. William Crozier, Chief of Ordnance is self-explanatory: "I give herewith the best records made so far during this target year with 12-inch B. L. rifles mounted on disappearing and non-disappearing carriages. The best record for accuracy is held by the 61st Company, Coast Artillery, at Fort Baker, Cal., with disappearing carriages. It made four hits out of four shots fired in 6 minutes 33 seconds, at a target moving seven miles an hour at a range of about 4,000 yards (2⅓ miles). The best record for speed is held by the 35th Company, Coast Artillery, at Fort Monroe, Va., with disappearing carriages. It made three hits out of four shots fired in 4 minutes 20 seconds at a target moving about 5 miles an hour at a range of 5,000 yards, (3 miles). The best record for both accuracy and speed with non-disappearing carriages is held by the 61st Company Coast Artillery, at Fort Baker, Cal. It made two and one-half hits out of four shots fired in 5 minutes and 40 seconds at a target moving about seven miles an hour at a range of 4,200 yards, (2½ miles). From data at hand it would seem to be a fair statement to say that so far as the problem of hitting is concerned, the disappearing carriage has the advantage of the non-disappearing carriage in the greater rate of fire attainable. The above examples are not much above the average for guns mounted on disappearing carriages. The results obtained with the non-disappearing carriage are most unusual, the next best record with this carriage for speed being four shots in 9 minutes 55 seconds, range 5,000 yards, speed of target 6½ miles, one-half hit made. Even this is above the average.

"I have no hesitation in saying that for all purposes I believe the disappearing carriages mounted on our coast to be the best service carriages, on land mounts for heavy caliber guns, in the world."

Submarine Boat for Coast Defense.

The submarine torpedo boat Protector, designed by Mr. Simon Lake, has been awaiting trial by a naval board, but owing to ice in Narragansett Bay on January 12—the day set for the beginning of the trials—the board temporarily abandoned its work. A week later, with the water and weather conditions even more trying, an army board put the vessel through a series of maneuvers of a most convincing nature. The immediate result of the military examination of the vessel was an official report recommending the purchase of five submarines of the Lake type. That report, in turn, was referred to the General Staff of the army, and the General Staff has now added its confirmation to the recommendation of the examining board.

The examing board was composed of officers of the artillery corps, which now has control of the country's submarine coast defenses. These officers were Major Arthur Murray, senior officer of the School of Submarine Defense at Fort Totten, N. Y.—and his associates, Captains Charles J. Bailey and Charles F. Parker. These officers had likewise been detailed to watch the trials and performances of the submarines now in the navy, but they did not find those boats susceptible of military adaptation for coast defense. The Protector, on the other hand, seemed to augur well for such service, and her performance on the day of trial, as well as the well known sea-going record of the craft, are substantiation,

The military aspect of the question is summed up in the following particulars cited by the board; and, in passing, it may be said that this military view of the field of usefulness of the Lake submarine is quite coextensive with the widest field of service now contemplated by the navy.

FOR DEFENSE.

First: To take the place of fixed mines, by lying adjacent to the forts and attacking vessels attempting to reduce the works or to run past, particularly in important channels where it is impracticable to plant mines, owing to deep and rough water, extreme width, or the swiftness of currents.

Second: To supplement fixed mines, by attacking vessels approaching the mine fields or those which have crossed them.

Third: To lie outside mine fields for scouting or picket duty, keeping in telephonic communication as hereafter described.

Fourth: To pick up and to repair defective cable joints, junction-boxes, etc.

FOR ATTACK.

First: To run past the forts, and to attack vessels within the harbor.

Second: To drag for, pick up, and to cut multiple and branch cables on the bottom, or mine cables leading to buoyant mines or buoys.

Third: To sweep the channel, two submerged boats being connected by a light cable extending across all or a part of the mine field.

To a very large extent, the board's attention was centered upon the diving compartment. This compartment is located in the bow of the craft, and is separated from the crew-space lying immediately abaft by an air-lock; and both the diving compartment and the air-lock are fitted with air and water-tight doors. The compartment is fitted with a connection to the low-pressure air system, and provided with a telephone communication with the living space, and a hydro-pneumatic gauge with two hands, one of which registers the pressure of the water outside—due to depth—and the other the air pressure in the compartment. At the bottom of the compartment is an iron door, which can be opened outward. To open the door, the air-lock doors are first closed, and compressed air is admitted into the compartment until the gauge hands indicate unity of air and water pressures. The door is then unfastened and allowed to swing open, thus giving, in clear water with the boat on the bottom, a good view of the sea bed.

This compartment provides for:

1. Mine cable cutting; or else repair of, or the burying of, mine cables and junction-boxes.
2. A channel for telephonic communication with the shore when the boat is on picket duty.
3. A way of escape for the crew, in case of the total disablement of the boat.

The board, remarking upon the ability of the Protector to run under gasoline propulsion with only the observing instrument and sighting-hood above water, said: "By reason of an automatic induction valve in the top of the sighting-hood, admitting air for the gasoline engines and excluding spray and water, the engines may be used in this condition of submergence; and this fact gives to the boat a large cruising radius at comparatively high speed, and renders it likely that under many conditions of sea, light, and weather, the craft may get within torpedo range without being seen, in the event even of the total disablement of her electrical equipment. In this condition, of course, the omniscope would be housed, and the sighting-hood, of a neutral color, could be discerned only with great difficulty. This ability of the boat to run under gasoline propulsion almost entirely submerged assumes considerable importance when it is considered that the elements most liable to disability in the submarine boat of to-day are the storage battery and the electrical equipment".

The following quotation from the board's report gives the experience of its members:

The board was on board from 10:15 A.M. to 4 P.M., of January 19, 1904. From about 12 M. to 3 P.M. the boat was submerged, and from 12:40 to 2 P.M. the board was in the diving compartment, observing its operation and that of grappling for a cable.

No discomfort was experienced under the air pressure in the diving chamber, and the remaining part of the interior was quite as comfortable as any surface boat of its size would have been. Lunch was cooked and served while submerged.

PROGRAMME.

1. Proceeded from Fort Adams (Newport, R. I.) some three miles up Narragansett Bay in cruising condition, using engines.
2. Passed from cruising to awash condition, housing all external fittings except a wooden mast installed for the naval test.
3. Continued surface run in awash condition.
4. Passed to submerged condition by filling ballast tanks.
5. Maneuvered on the bottom of the bay, by using storage batteries and motors to propel the boat.
6. Filled diving chamber with compressed air, opened door in bottom, and, with a grapnel, picked up a telephone cable by moving slowly over its approximate position.
7. Passed from submerged to awash, and thence to cruising condition, and returned to Fort Adams by a surface run, using storage batteries and motors.

In passing from the submerged to the awash condition, it was found that an ice floe had drifted over the boat, which, on rising, broke through the floe and emerged with its deck completely covered with some eight inches or more of ice, which remained on deck while passing to the cruising condition. It was also found that the wooden mast above mentioned had been broken by the ice while the boat was maneuvering under it.

The weather was very cold (zero) the bay full of ice, and it would have been difficult to have chosen more adverse conditions for the test.

CONCLUSIONS AND RECOMMENDATIONS.

For Defense.

The board believes that this type of submarine boat is a most valuable auxiliary to the fixed mine defense, and, in cases where channels cannot be mined owing to depth, rough water, swift tides, or width of channel, it will give the nearest approach to absolute protection now known to the board. The boat can lie for an indefinite time adjacent to the point to be defended, in either cruising, awash, or submerged condition, by its anchors being upon the bottom. It is thus ready for instant use, practically independent of the state of the water, and in telephonic connection with the shore. It can also patrol a mined or unmined channel, invisible to the enemy, and able to discharge its torpedoes at all times. It possesses the power of utilizing its engines in every condition except the totally submerged, and can always charge its storage batteries while so doing, necessitating its return to shore only when gasoline must be replenished. In narrow channels the boat or boats would have a fixed position, with a telephone cable buoyed or anchored at the bottom. In wide channels they would patrol or lie in mid-channel, or where they could readily meet approaching vessels.

As a picket or scout boat, outside the mine field or even at extreme range of gun fire, telephone communication can be sustained, and information received and instructions sent for attacking approaching vessels.

The test at Newport demonstrated the ease with which the boat can locate and pick up cables and, with minor alterations in the present model, junction-boxes, etc., can be taken into the diving compartment and repaired at leisure while absolutely protected from hostile interference. The faculty possessed by the boat of maneuvering on the bottom and sending out divers, leaves little or nothing to be desired in its facilities for doing this work.

FOR ATTACK.

The boat shows great superiority over any existing means of attacking mine fields known to the board.

It can run by any mine field, as at present installed, with but little or no danger from the explosion of any particular mine or from gun-fire, during the few seconds it exposes the sighting-hood for observation, and can attack at its pleasure vessels in the harbor.

The board personally witnessed the ease with which cables can be grappled, raised and cut, while the boat is maneuvering on the bottom. Mine cables can be swept for, found and cut, or a diver can be sent out for that purpose.

It should be noted that, with one exception, no seamen are needed aboard, this exception being the man who steers and handles the boat.

The crew is as follows: One navigator, who is also the diver; one chief engineer, one assistant engineer, one electrician, one machinist, one deck hand, one cook.

The board recommends consideration of the foregoing by the General Staff. The question of the use of the Whitehead torpedo as part of the fixed mine defense, fired from tubes on shore, is now receiving consideration. Where channels are wide and waters swift, this use of the Whitehead will be very limited. With boats of this type the Whitehead can, it is believed, be carried within certain effective range in all ordinary channels, and this, alone, will warrant the consideration asked.

The board recommends, in consequence of its conclusions, that five of these boats be purchased for use in submarine defense, as follows:

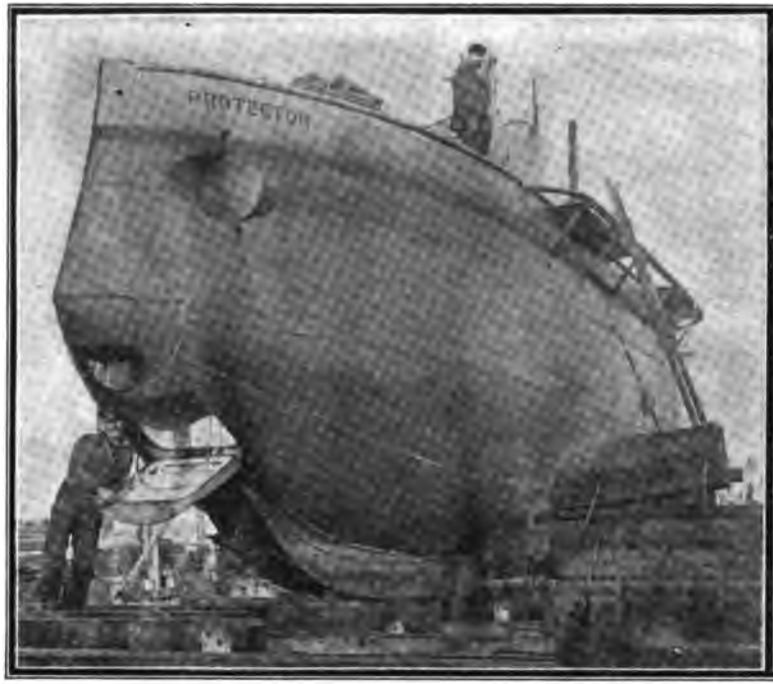
One for the School of Submarine Defense, for experimental work. One for the eastern entrance of Long Island Sound. One for the entrance to Chesapeake Bay. One for San Francisco Harbor. One for Puget Sound.

The necessity for this kind of defense in the four localities named, needs no demonstration, to those acquainted with them.

—*Scientific American*, March 12, 1904.

Hearings on the Fortifications Bill.

Major General George L. Gillespie, former Chief of Engineers and now Assistant Chief of Staff, U. S. A., appeared before the sub-committee of the House Committee on Appropriations having in charge the Fortifications Appropriation bill on Feb. 11. With regard to the item of $2,250,000 for gun and mortar batteries for harbor defense, General Gillespie stated that our chief harbors are in a good state of defense, except that guns of lower calibers are needed for taking care of torpedo boat destroyers. "We hold," he said, "that in order to secure economical construction, it is better not to abandon any of our plant, as a plant not used deteriorates very rapidly. Our idea is to carry



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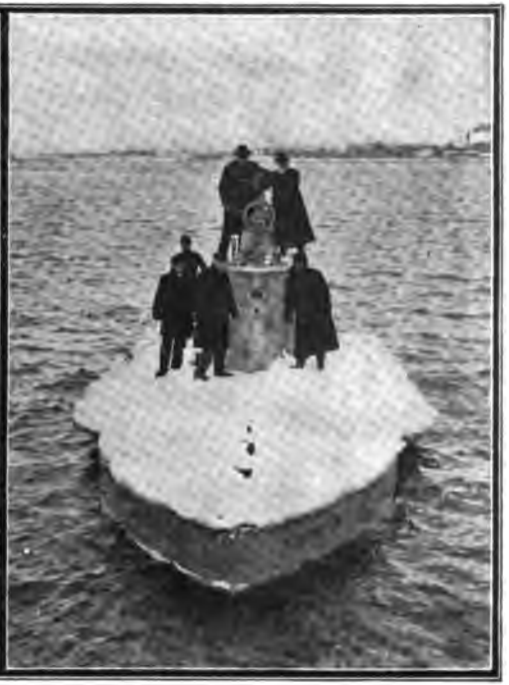
The "Protector" in Drydock, Showing Diving-Compartment Door Open.

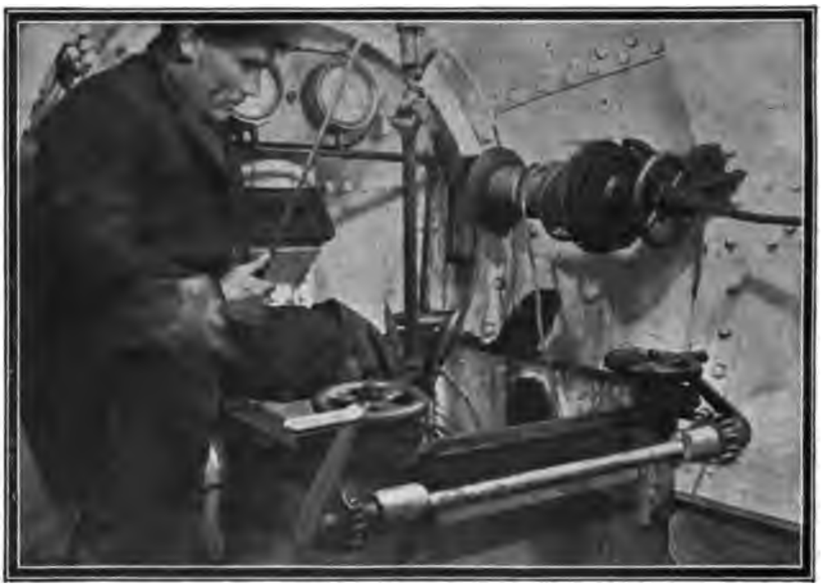


The Ice-Covered "Protector" After a Run.

Army Board members on the deck and conning tower.

Submarine Boat Protector.

The accompanying illustrations show the appearance of the boat after rising under a huge cake of ice 8 inches or more in thickness; the interior of the diving compartment; and the bow of the boat when in dry dock. The last named is the most striking picture. One torpedo tube is shown, the bow anchor-weight hole, and the door of the diving compartment. The interior view of the diving compartment shows the grapnel bringing up a cable through the door in the floor. The windlass at the side is used to haul up the grapnel after it has picked up a cable. The small rectangular glass in the front of the compartment is for looking at the bottom without opening the compartment door. The tube from this glass leads into the anchor-weight hole in the bow, and so this window can only be used when the weight is out of its casing. The diving compartment is the great feature of the Lake submarine that distinguishes it from all others. The picture of the ice-covered boat tells its own story and shows that the new submarine is ice as well as water-proof, and could be used for breaking a channel by running under the ice and coming up under it, if it could be done in no other way.



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The Diving Compartment, Showing Windlass and Grapnel Bringing up a Cable from the Sea Bottom.

out the proper defense at each one of our harbors, so as to finish the projected armament as quickly as possible. We must make it a continuous construction until each and every one of our harbors has an adequate defense against probable attacks. Ordinary precaution demands a certain defense at every important harbor subject to attack. Boston, for example, is hard to defend because it lies so close to the sea, or Narragansett Bay, which has a double entrance, and to make both secure we have to have correspondingly increased armament. Defense of Narragansett is necessary to give protection to the eastern approach to New York City itself. Without these defenses one of our active naval fleets would have to lie there and guard that eastern entrance. Then come New York, New Orleans, San Francisco and Puget Sound. Some of the other places have comparatively few guns. Charleston has a fairly good defense; so has also the mouth of the Savannah River. While we claim we have a fairly good defense, it is not a defense that we could leave to itself; the heavy armaments should be supplemented by auxiliary guns, which we have not up to this time provided. We have not the full supply of torpedoes, but they can be manufactured very easily. A torpedo is very easily manufactured, and if we only have the money we can supply them rapidly. We have a very good defense as far as the large guns are concerned, but the smaller caliber guns are not yet supplied in anything like sufficient quantities."

In urging the item for the installation of search lights, General Gillespie said the matter was one of the utmost importance. "It is probable," he remarked, "that the Russians at Port Arthur had search lights of very small caliber only, because they were not able to illuminate surrounding waters, and they did not discover the little torpedo boats. At the time of the sea maneuvers in 1902 the calibers of our adopted types of searchlights were 30 inch, 34 inch and 36 inch. We had two 60-inch caliber in use, one on Gull Island and one Fishers Island, the latter an experimental one procured from the General Electric Company at Schenectedy. They did very efficient work. The water was illumined nicely. The knowledge we acquired by the experience of the maneuvers of 1902 was still further enlarged in the maneuvers of last year at Portland. We have not yet adopted any general project which will absolutely determine the number of lights that will be needed at any one harbor. It is a study. We are still to solve the problem. We are working now on an effort to reduce the number of lights, and to obscure them in such a way that their light will not be shown continuously, by which the enemy is enabled to determine the ranges or exact location, and therefore better prepared to destroy the lights. It is a subject that is very worthy of continuance. To properly install a 12-inch gun costs nearly $100,000. If we can get a 60-inch or less caliber search light, whose use will be so efficient as to cause a reduction in the number of our guns, we have by so much reduced the cost of our fortifications."

With reference to fortifications in insular possessions, General Gillespie pointed out that there are six harbors that are sought to be protected at this time: San Juan, in Porto Rico; Honolulu and Pearl Harbor, in Hawaii; Guam, Manila and Subig Bay. The General made the following statement: "I would like to say a word right here about Manila and Subig Bay. That question was discussed very thoroughly before the joint Army and Navy Board, and the engineer members of that board insisted it was inexpedient to defend Subig Bay unless you were also able to defend Manila. The two go together; one is representative of the Army establishment and the material wealth of the island groups, and the other is representative of the naval establishment. Of course, there is great reason why the Navy should be at Subig Bay, but to say that Manila will be defended by Subig Bay cannot be accepted, because it is 30 miles away. I think that view is acknowledged by the Navy. Considering the amount of money that we have spent to hold our position out there, and the probability of permanent occupancy, I think $2,006,000 would not be too much to spend at the entrance to Manila alone. The work will be very difficult to execute. The central part of the channel is nothing but rocks. The construction, I suppose, would be 20 or 25 per cent. more costly than here. The water is so deep that we could not use mines very effectively, although we would place them on the inside where the water is shoal. The fortifications which Spain left amount to nothing at all. They had a few guns on Corregidor Island, but no modern guns of any description. At San Juan, in view of Cuban troubles, the Spanish Government had congregated a few of what they called modern guns, but the Ordnance Department say they are worthless; they could not stand smokeless powder charges at all, and when the question came up of utilizing the Spanish 6-inch guns at San Juan, they stated it would be cheaper to send new guns. In the Philippines we have not a single high-power gun except a few that the Navy say they have sent to Cavite for special purposes."

Brig. Gen. William Crozier, Chief of Ordnance, U. S. A., who followed General Gillespie, said in reply to inquiries that present estimates do not look to the purchase of forgings for any 8, 10 and 12-inch guns in the immediate future, the projected number of such guns being nearly finished. The large plant at the gun factory at Watervliet is now being utilized in manufacturing guns for the Navy from forgings which they furnish and from their own designs.

As to the possibility of getting an abundant supply of smokeless powder, General Crozier said: "I will say that there are four establishments in the country from which we can procure powder, and their capacity is, I think, fully up to our needs and ahead of that which we utilize in time of peace. I think that it would be highly desirable for the Department to have a powder plant of sufficient capacity to make experimental lots. That is, the smallest that can be made after the same methods that would be used in making large amounts, in order that we might more carefully study everything in connection with powder and in order that our officers might become more thorough masters of the subject; but I have never submitted an estimate for such a powder plant, and in my present frame of mind in regard to it, I would not contemplate such a plant as contributing to the stock of powder for utilization; but only to the experimental handling of the subject in order to increase our knowledge."

Referring to the item of $235,760 for the purchase of steel breech-loading mortars of 12-inch caliber, the chairman remarked that there had been no appropriation for such purposes for the last three years, and asked whether it was the intention to continue the emplacement of mortars. General Crozier said in reply: "I think that the mortars are useful for the purpose for which they were originally designed, which is to forbid the occupation of certain waters as gathering places for hostile vessels, or resting places for such vessels, and I think that the practice we have had has shown that they are useful even for other purposes than those for which they were originally contemplated. That is to say, we have found that they have very reasonable accuracy when used against moving vessels. I will add, however, that I think a small number of them, comparatively, at each place where they are installed, is sufficient to accomplish the object originally intended to be accomplished, to prevent vessels occupying certain positions from which they might do damage or from which they might make a fresh start for another position which we would wish to keep them out of. I therefore consider that they form desirable elements in any new project of defense, but that it is hardly necessary to add additional numbers at the places where we now have them."—*Army and Navy Journal*, February 20, 1904.

Fortifications Bill, United States.

The Senate on March 15 passed the Fortifications Appropriation bill which had been previously passed by the House on February 18. There was much discussion of the amendment authorizing the purchasing of an experimental torpedo boat and the provision for the purchase of sites for defense works in the Hawaiian Islands. The torpedo boat provision was stubbornly fought, but the amendment suggested by the Committee on Appropriations was retained. The Hawaiian provision, which had been eliminated by the committee, was restored, and the sum increased from $200,000, as fixed by the House, to $526,100.

On the question of the purchase of a submarine torpedo boat for experimental purposes Mr. Alger said that from his experience in the War Department he believed a boat of the type designated was needed for coast defense.

The committee amendment for a submarine boat was agreed to.

In response to a request from Mr. Lodge, Mr. Perkins explained the reasons which actuated the committee in striking out the House provision of the bill appropriating $200,000 for the purchase of sites for defenses in the Hawaiian Islands, saying that the committee's action had been due to the fact that the government had no option on land for this purpose, which might have the effect of placing the government at the mercy of real estate owners. He also said the amount named was not sufficient.

Mr. Spooner and Mr. Foraker took the position that on account of the outlying position of Hawaii the United States should be prompt in providing for its protection, and Mr. Perkins said he was willing, if a sum sufficient to accomplish the purpose could be secured. In accordance with Mr. Perkin's suggestion Mr. Spooner offered an amendment appropriating $526,100, instead of $200,000. This amendment was accepted without division.

The text of the bill follows:

* * * * * * * * *

FORTIFICATIONS AND OTHER WORKS OF DEFENSE.

For construction of gun and mortar batteries, $700,000.

For installation of range and position finders, $225,000.

For the procurement or reclamation of land, or right pertaining thereto, needed for the site, location, construction, or prosecution of works for fortifications and coast defenses, $100,000.

For purchase and installation of searchlights for the defenses of our most important harbors, $150,000.

For the protection, preservation and repair of fortifications for which there may be no special appropriation available, $300,000.

For preparation of plans for fortifications, $5,000.

For tools, electrical and engine supplies and appliances, to be furnished by the Engineer Department, for the use of the troops for maintaining and operating electric light and power plants in gun and mortar batteries, $35,000.

For construction of sea walls and embankments, $99,000.

For the construction of mining casemates, cable galleries, torpedo storehouses, cable tanks, and other structures necessary for the operation, preservation, and care of submarine mines and their accessories, $87,000, to be expended by the Engineer Department.

* * * * * * * * *

To enable the Secretary of War in his discretion to purchase for the School of Submarine Defense for experimental work one submarine torpedo boat of the type of the Protector, manufactured by the Lake Torpedo Boat Company, not to exceed, in the judgment and discretion of the Secretary of War, $250,000: Provided, That before said submarine torpedo boat is purchased or accepted by the War Department it shall have been fully tested to the satisfaction of the Secretary of War and shall fulfill all reasonable requirements for coast defense.

ARMAMENT OF FORTIFICATIONS.

For the purchase, manufacture, test, and issue of machine and automatic guns, including their carriages, sights, implements, equipments, and the machinery necessary for their manufacture at the arsenals, $210,229.

For the purchase, manufacture, test, and issue of mountain, field, and siege cannon, including their carriages, sights, implements, equipments, and the machinery necessary for their manufacture at the arsenals, $584,200.

For the purchase, manufacture, test, and issue of ammunition for machine and automatic guns, and for mountain, field and siege cannon, including the necessary experiments in connection therewith, and the machinery necessary for its manufacture at the arsenals, $261,600.

For the purchase, manufacture, test, and issue of rapid-fire guns for coast defense, including their carriages, sights, implements, equipments, and the machinery necessary for the manufacture at the arsenals, $618,000.

For the purchase, manufacture, test, and issue of ammunition for rapid-fire guns for coast defense, including the necessary experiments in connection therewith, and the machinery necessary for its manufacture at the arsenals, $107,000.

For the purchase, manufacture, test, and issue of seacoast guns and their mounts, including sights, implements, equipments, and the machinery necessary for their manufacture at the arsenals, $180,000.

For the purchase, manufacture, test, and issue of ammunition for seacoast cannon, including the necessary experiments in connection therewith, and the machinery necessary for its manufacture at the arsenals, $330,000.

For the purchase, manufacture, and issue of inspecting instruments for the manufacture of cannon, carriages, and ammunition; range finders and other instruments for fire control at the fortifications and in field batteries, and the necessary machinery for their manufacture at the arsenals, $217,500.

For the purchase, manufacture, and issue of ammunition, subcaliber tubes, and other accessories for artillery practice, including the machinery necessary for their manufacture at the arsenals, $374,000.

For the alteration and the maintenance of the mobile artillery, including the purchase and manufacture of lathes, tools, and materials necessary for the work and the expenses of the mechanics engaged thereon, $11,000.

For the alteration and maintenance of the seacoast artillery, including the purchase and manufacture of lathes, tools, and materials necessary for the work, and the expenses of the mechanics engaged thereon, $500,000.

For 8-inch, 10-inch, and 12-inch guns, manufactured by contract, under the provisions of the fortifications Acts approved August 18th, 1890, and February 24th, 1891, $201,000.

* * * * * * * * *

SUBMARINE MINES.

For the purchase of submarine mines and necessary appliances to operate them for closing the channels leading to our principal seaports, and continuing torpedo experiments, including extra duty pay to soldiers necessarily employed for periods not less than ten days on work in connection with the issue, receipt, aud care of submarine mining material at the torpedo depot, $100,000.

FIRE CONTROL INSTALLATIONS.

For the purchase, installation, operation, and maintenance of the necessary lines and means of electrical communication, including telephones, dial and other telegraphs, wiring and all special instruments, apparatus and materials, and salaries of electrical experts, engineers and other necessary employees, connected with the use of coast artillery, $500,000.

FORTIFICATIONS IN INSULAR POSSESSIONS.

For construction of seacoast batteries in the insular possessions, $700,000.

For procurement of land needed as sites for the defenses of the Hawaiian Islands, $526,100.

For the purchase, manufacture, test, and issue, for the insular possessions, of seacoast guns and their mounts, including sights, implements, equipments, and the machinery necessary for their manufacture at the arsenals, $178,920.

For the purchase, manufacture, test, and issue, for the insular possessions, of seacoast mortars, with their mounts, including sights, implements, equipments, and the machinery necessary for their manufacture at the arsenals, $78,000.

For the purchase, manufacture, test, and issue, of rapid-fire guns for coast defense for the insular possessions, including their carriages, sights, implements, equipments, and the machinery necessary for their manufacture at the arsenals, $162,000.

* * * * * * * * *

That all material purchased under the foregoing provisions of this Act shall be of American manufacture, except in cases when in the judgment of the Secretary of War, it is to the manifest interest of the United States to make purchases in limited quantities abroad, which material shall be admitted free of duty.

A. H. EMERY ELEVATING CARRIAGE.

To enable A. H. Emery to proceed promptly in the work of building and erecting the 12-inch disappearing carriage and its loading apparatus being made by him for the Government, it is hereby provided that the Secretary of War may, in his discretion, advance the said Emery, at any time or times which he thinks best, any part of the $84,343.02, balance of appropriations now available for completing the construction, erecting, and testing of the said 12-inch carriages and its foundations and loading apparatus, and making the preliminary tests thereof: Provided also, That the Secretary of War is, in his discretion, hereby authorized to close the contract with said Emery, under which he is now making this 12-inch carriage and its loading apparatus, by relieving him from all further work thereon and contracting with him for either an eight or ten-inch disappearing carriage to be furnished by him in place thereof, together with its foundations, erection, and preliminary tests by him ready for the proof tests by the Board; and to pay therefor to the said Emery the said balance of $84,343.02, balance of appropriations above mentioned, in such sums, and at such times as he shall, in his discretion, think best, to enable the said Emery promptly to construct and erect said carriage and its foundations and make the preliminary tests thereof, ready for its proof tests by the Board.

The New Field Gun Carriage. England.

Evidence has not been wanting of late that the War Office is actively bestirring itself to improve the existing model of field gun carriage. The South African war showed that our field artillery was frequently placed at a disadvantage by reason of the well-nigh obsolete form of carriage that was used. Whether it was truly obsolete at the commencement of the war may be open to argument, but now at any rate it is certain that the modern field gun carriage must be such as to allow for the separate recoil of the gun, instead of gun and carriage going back as one piece.

As a general truth it may be stated that the gun recoils approximately 1½ inches during the time that elapses from the first movement of the shot inside the bore to its departure from the muzzle. As soon as the shot is gone the gases follow with great rapidity, so that the above distance of recoil may fairly be taken as covering the distance through which the gun moves while building up its maximum energy of recoil. This energy, whatever may be its value, is taken up by the action of the gun carriage in cutting its way into the ground on which it stands. The necessary grip is mostly provided by a spade which is forced into the ground by the trail of the gun. The resistance necessary to bring the gun to rest may be calculated theoretically by dividing the number of foot-pounds energy of recoil by the distance which the gun covers in its backward travel. The trail should evidently be of sufficient strength to sustain the thrust that would occcur in gound affording a maximum of grip, and, therefore, a minimum of travel before coming to a standstill.

The disadvantages of a solid mounting as between gun and carriage, are that the gun has to be relaid after the firing of every shot, so that a considerable amount of time must elapse between the rounds. The amount of displacement that the gun sustains by the firing of each shot is a variable quantity since there is no certainty either as to the grip it will obtain, or even that it will recoil in a straight line. More than this the possibility that guns may be used on ground having a sandy or other unsuitable surface, places a limit on the strength of the ammunition that can be used. The recoil, be it understood, is in close relation to the power of the ammunition.

Where guns are attached to naval mountings the recoil is dealt with in a far more scientific fashion than occurs with field carriages. Sometimes pneumatic, but mostly hydraulic, buffers act as an elastic connection between the gun and its mounting, the recoil in such instances being taken up by a definite resistance which is applied over a considerable distance of backward travel. As the distance of recoil is increased, the actual thrust on the fixed mountings of the gun is considerably reduced, a condition which is essential to guns which are bolted to the deck of a ship. The French were among the first to apply the principle of the buffer to field gun carriages, with the result that the rapidity of fire is greatly increased, the manipulation of the gun being proportionately simplified. The widely held view that the buffer system of recoil absorption would introduce complications of an objectionable character in the handling of field artillery has been found to be erroneous, the balance of advantage undoubtedly lying with the system that gives greatly enhanced efficiency at a comparatively small cost in the way of extra mechanical risks.

At any rate the experiences of the South African war afforded conclusive proof that the British pattern of field gun carriage was in sore need of being brought up to date. It was clearly seen that the efficiency of artillery fire must be greatly enhanced, though of course experts will always disagree as to how far this should be done by increasing the velocity of existing shells, or whether the shells themselves should be increased in weight, thereby increasing their ranging power. Whatever may be the particular answer to this question, one thing at least is clear, viz., that the new carriages must be capable of absorbing a greater amount of recoil than the old type and that the time lost in relaying the gun after firing must be materially reduced.

The War Office some time back invited various leading ordnance manufacturers to submit hydraulic field gun-carriages for the purposes of practical trial. This was with a view to the adoption of a satisfactory model to be sealed in due course as a service type. The arranged characteristics of the new design were that the gun should have a long recoil within its own mountings, and that elevation and traverse should be provided for as between the gun and its carriage, instead of by altering the position of the carriage itself relatively with the ground on which it stands. The invited firms accordingly lost no time in submitting models of carriages for the War Office experiments, and so far as information on such matters is available, there seems to be no reason to doubt that thoroughly satisfactory results have been attained. With French experience before us, it naturally follows that the designs separately arrived at by the competing firms must follow on very much the same lines. This facilitates the task of embodying in the new service gun carriage the best features of all available systems. A characteristic of all recoil-absorbing field guns is that they have a very much more rakish appearance than those of the old pattern. This mainly arises from the fact that the spreading of the recoil over a prolonged thrust reduces the amount of strength required in the trail. The recoil mechanism itself is necessarily made as compact as possible, so that judging from the French and American models of gun, which work on the same general plan, very little mechanism lies outside the space enclosed by the wheels of the carriage.

One of the most important points of field gun-carriage construction, which has yet to be mentioned, relates to the sighting of the gun. In the French gun there is an independent movement between the sighting bar and the gun itself. In this way after laying the sights on the target, with an elevation appropriate to the estimated range, the sights remain fixed whatever may subsequently be done to the gun. Thus when it is found that the shot strikes either high or else short of the object aimed at, the gun may be raised or lowered in elevation without affecting the alignment of the sights. This represents a considerable saving of time as compared with the alternate process of re-adjusting the elevation of the sights and then relaying the gun to accord with the new conditions.

The importance of this refinement in the sighting process may not at first be appreciated by persons who are not practical artillerists. Those who are used only to the handling of small arms will be unaware of any objection to the operation of removing the gun from the shoulder and re-aligning it on the target after making any required alteration of the sights. Field guns on the other hand are not so readily manipulated. Hence the need for an independent movement of the sights of the gun. The sights being once aligned on the object of attack should so remain, the axis of the gun being thereafter subject to correction, according to the observed results of the shooting. This refinement of sighting would obviously be of no use in dealing with guns with fixed mountings on the carriage, because the disturbance of the gun's alignment after the firing of each shot in any case involves its complete relaying.

—*Arms and Explosives*, January, 1904.

Vanadium Steel.

Metallurgic circles, especially abroad, have been interested recently it the singular properties of vanadium steel.

It appears that when from 3 to 5 parts per 1,000 of this metal, which is as yet very little known, are added to steel, it communicates remarkable properties.

Properly speaking, vanadium does not bestow on iron or steel any new property, but it doubles the coefficients of resistance to fracture under all circumstances (shock, crushing, elongation, etc.) and at the same time imparts such extreme hardness as to render it possible to reduce almost by half the thickness of the armor for vessels.

It is difficult to comprehend that the presence of from ⅓ to ½ per cent. of any element whatever in an iron alloy can have so intense and general an effect, though this effect is perhaps explained by the extreme avidity which under certain circumstances vanadium has for oxygen. This avidity might account for the fact that the presence of even the slightest quantities of vanadium in a bath of steel in fusion would lead to the immediate and absolute reduction of every trace of iron oxide still existing in the mass; now to these traces of oxide, which are inevitable without vanadium, the rupture of the best prepared steels is attributed. Crystals, even microscopic, of oxides would act like the stroke of a diamond on the thickest glass.

A peculiar property of vanadium steels is that they acquire their maximum of hardness, not by tempering, but by annealing at from 700° to 800° C. This has various consequences; for instance, a planing machine whose cutter is of vanadium steel is set at work with the greatest velocity and power. Soon the implement becomes heated, and even when it attains red heat, it still continues to take off shavings of iron or castings without exhibiting any exhaustion. It is almost unnecessary to remark that in such a case a cutter of ordinary steel would become completely softened and lose its cutting power.

This property is of particular importance for projectiles. It is known that the shock which they experience on striking the target raises them to an elevated temperature. If, by means of vanadium, this temperature does not diminish the hardness of their points, and consequently all their sharpness is preserved, the penetrating force will remain intact.

The applications of vanadium may be numerous. It is said that they may cause a revolution in armaments. Incidentally, they would allow the construction of helmets and breast-plates, light and efficacious.

Vanadium has been valued as high as 130,000 francs per kilogram. It is now, we think, worth about 150 francs.

—*Journal Franklin Institute*, January, 1904.

Harmet Process for Steel.

Capt. E. L. Zalinski, U. S. A., retired, sends the following description of the Harmet process, and will be glad to furnish any further information on the subject:

The Harmet process of compression of steel by wire drawing was invented by Monsieur Henri Harmet, director of the steel company of St. Etienne. This process has been introduced in various establishments in France and in Cammells, Monkgridge Steel Co. and Beardmores in England. Preparing to carry out this process requires a considerable plant, but the cost of working is exceedingly low. It results in securing every ingot, absolutely and microscopically sound from top to bottom.

One of the advantages gained by using the process is that less of the ingot need be cut off. For example: The French Government's specifications insisted upon 33 per cent. being cut off the head of the ingot and 6 per cent. at the base. Since the introduction of Harmet's fluid compression they have altered their specification for steel made in his presses, insisting upon only about four per cent. being removed from the top, where the ingot is slightly irregular.

Cammell's press, which only deals with ingots of five tons and is capable of turning out about thirty tons per day, has been in continuous and steady work, and the demand for the steel has so increased that a new and larger plant is now being negotiated for. Presses are being built capable of handling twenty to forty tons to each compression.

With the Whitworth process the steel, when in a fluid or viscous state, is compressed by applying pressure to the top of the ingot and forcing it in a downward direction; the fluid steel is pressed against the sides of the mould causing a dilation and distention of the metal from the center towards the periphery. As the ingot cools from the outside towards the center the strains thrown upon the steel are such that the actual center of the ingot is porous and of distinctly lower quality than the exterior, which has received the greatest amount of pressure.

The Harmet process is distinctly opposite. The mould reinforced with hoops to resist the strain, is conical. The piston from below commences to rise as soon as the mould is brought under the press, and it throws a strain from the periphery towards the center to an extent greater than any known hydraulic press. Beardmore's press, for instance, has a pressure of 5,000 tons, and a slope of about one in forty to the side of the mould—the resultant pressure towards the center is enormous. This pressure, by a very simple arrangement of valves, rises up to its maximum according to the resistance, due to the cooling of the mass, and when it has reached its maximum it is maintained by accumulators until the mass is absolutely solid from periphery to center. The process is applicable to alloys and bronze as well as steel, producing thereby results which were heretofore unobtainable.

In view of what the examinations have shown of the existence of flaws in the forging of the guns which have recently been burst on the Iowa, it seems as if this new process should be considered by our steel makers, as it involves both economy and excellence of material produced.

—*Army and Navy Journal*, March 12, 1904.

The Belleisle Torpedo Experiments.

The old battleship Belleisle, which was sunk on September 4 by an 18-inch Whitehead torpedo, has been floated and docked at Portsmouth. The experiment was one of the most important that has ever been carried out with the Whitehead torpedo, as the ship had been so stiffened as to be stronger below the belt than any seagoing warship; but, on the other hand, by way of compensation the torpedo was specially favored. Outside the ship, just abaft the port bow, was built a compartment about 2 feet in beam, and this was filled with corn-pith cellulose; next to this compartment came the skin of the ship; between the skin of the ship and the boiler room were six longitudinal bulkheads, and these were intersected by a transverse bulkhead extending from the boiler room to the skin of the ship. Two of the longitudinal compartments had a beam of 3 feet 6 inches, and each was filled with coal. The Whitehead torpedo was lashed under the outer casemate that was filled with corn-pith cellulose, and was electrically fired from the Vernon. If the conditions did not exactly comply with what would obtain in actual warfare, it will be seen that in the handicapping the ship was given the advantage. As a matter of fact, however, the outside casemate with its cellulose was blown into the air the instant the torpedo was exploded, the bulkheads were shattered, and the decks were so blown up inwards, upwards, and downwards that not a ton of coal could be found in the original emplacement. The work of destruction in a latitudinal line stopped at the bulkhead of the boiler room; but the extraordinary radius of the explosion afforded some useful instruction.

When it was found that the ship was sinking in deep water she was pushed by the tugs on to a mud bank, and then the Liverpool salvage crew were called in to salve her. Subsequent investigation showed that the hole in the side of the ship measured 12 feet by 8 feet, and revealed the fact that a considerable portion of the section of double bottom built on the ship's side was blown away, together with the cellulose contained. But this forms only a small portion of the damage done, for the explosion of the torpedo was of such tremendous force that it burst through the ship in every direction. Far into the interior the effect could be seen. The experiment has hardly proved that coal bunkers are of much value as a protection, for the coal was blown all over the ship.

By the time the salvage operations began this hole was being so rapidly silted up by the harbor mud that it could not be approached. Some deck plates were therefore blown out, but the divers when the ship was submerged found it impossible to go below. The explosion had so forced the bulkheads inwards and caused such jagged edges in the plates that there was no way through which a diver could crawl, and therefore all the work had to be done from the outside. By this time the greater part of the hole had been filled up, and nothing could be done until the mud had been removed. The salvors, therefore, had to employ a dredger, which removed 300 tons of mud. The dredger buckets could not get close alongside the ship, so a hole had to be dug in the bed of the harbor as near to the hole in the ship's side as possible, and then the mud that plugged the hole in the ship's side had to be ploughed into the cavity. Owing to the rapidity of the silting, this was a work of considerable difficulty, as it was only when the mud was kept below the vessel's wound that the shipwright divers could work to any purpose. Their first object was to plank up the bulkheads nearest the skin of the ship, and then to adopt the same course with the outside plates. Having thus secured a fairly watertight though waterloaded compartment, their next duty was to pump out the water and put in cement, which, by the action of such percolations as remained, stopped the crevices. Although she was lying on a mud bank, only the top of the conning tower was visible at high water, and when the salvors were ready to use the pumps the tide allowed them only five and a half working hours.

Their pumps, however, were equal to a discharge of 3,600 tons an hour, and they then had no difficulty in giving the ship such buoyancy in one tide that she was successfully towed across the harbor and placed in dry dock.

The result of the trial is regarded by the Torpedo School as such a success that the ship is to be brought forward for further torpedo experiments.

Manchuria.

Though Manchuria, the smallest of China's dependencies, is scarcely one-twelfth of the area of the Celestial Empire it is by no means a small country. The area of the southern province of Sheng-King is about 55,000 square miles; the central province of Kirin is nearly double that size, and the northern province of Hilung-chiang is twice the area of province Kirin, and almost exactly the same as that of France.

The boundaries, beginning at the Great Wall, are Outer Chili and Mongolia on the west; then, on the north and east the frontier marches with the Russian provinces of Trans-baikal, Amur, and Primorsk for 2,300 miles; while on the south it is bounded by Corea, the Yellow Sea, and the Gulf of Liao-tung.

The territory leased by Russia in March, 1898, known as the Kuang-tung district, contains an area of 1,050 square miles. Its boundary line, 35 miles in length, extends from the island of Po-lo-tao or Lu-tao in the Gulf of Liao-tung to a few miles to the east of the small port of P'i-tzu-wo on the north coast of the Yellow Sea. Beyond this frontier is a neutral zone extending northwards and bounded by the Kai-chou river, which flows into the Gulf of Liao-tung, and by the Ta-yang river, which empties itself into the Yellow Sea. In this neutral zone the Chinese are not permitted to quarter troops without the permission of Russia.

In this leased territory is the land-locked harbor of Port Arthur. This harbor is for the sole use of Russian and Chinese men-of-war. Its defects are that the anchorage for large large ships is very restricted and the water supply bad, which latter defect is common to all ports on the north coast of China. The fortress is strong on the sea front, the re-entrant form of the coast enabling the forts guarding the entrance to bring a converging fire on hostile ships; while the entrance to the harbor, 600 yards wide, is protected by submarine mines. On the land side there is a semi-circle of hills about 2½ miles from the dockyard, on which permanent works connected by entrenchments have been built.

The port contains a basin, a dockyard, extensive granaries, search lights on the sea and land fronts, and a permanent garrison of some 14,500 men.

Thirty miles east by north of Port Arthur is the Bay of Ta-lien-wan, which was used by the British Expeditionary Force as a rendezvous base in 1860. The Bay is six miles wide and six miles deep. The northern portion of the Bay, which is fortified, is reserved exclusively for Russian and Chinese men-of-war, while Dalny, on the south side of the Bay, is a commercial port open to the merchant vessels of all countries.

Both Port Arthur and Ta-lien-wan are practically ice-free ports.

Dalny is the commercial terminus of the southern branch of the Chinese Eastern Railway, being 5,415 miles distant from Moscow. The harbor, which is now under construction, will be the finest in the Far East. The largest ships will eventually be able to steam up alongside the piers. On these latter rails are laid and large warehouses built. Dry docks are being constructed, and a central electric station generates sufficient power to light the city, drive the machinery of the dry docks, and work the trams. This city has been constructed by the Eastern Railway Company at immense cost, and if the Imperial edict making it a free port be not reversed, it is destined some day to be one of the most important trade emporiums in the Far East.

Both Port Arthur and Ta-lien-wan are situated on the Kuan-tung peninsula, which is joined to the Liao-tung peninsula by a strip of land barely 3,300 yards in width. This point is the strategetical key to the Kuan-tung peninsula, and is now strongly fortified by a series of batteries. The flanks of this position are fairly secure, the left resting on the muddy foreshore of of Chin-chou Bay and the right protected by the works at Ta-lien-wan.

MOUNTAINS.

There are two distinct mountain systems in Manchuria, that in the west and north, consisting of the Khingan and Lesser Khingan ranges, and that of the south, composed of the Chang-pai-shan, the "Ever white mountain" and its offshoots.

The Khingan range begins in the extreme northwest corner of Manchuria, and extends for 800 miles in a southerly direction until it becomes merged in hilly country of Outer Chili. The lesser Khingan mountains separate the valley of the Amur from those of the Rivers Nonni and Sungari. These mountains, which cover a large portion of the northern province, seldom exceed four to five thousand feet in height. Except the trade route between Tsi-tsi-kar and Aigun there are no roads in this region, which is inhabited by wild tribes and Chinese hunters in search of furs. The whole of this country is clothed with dense forest and is practically unexplored.

Just north of the Corean frontier rises the Chang-pai-shan, so called from the whitish punice stone on its summit, which gives it the appearance in summer of being snow-capped, though its elevation is but 8,000 feet. In Manchuria the Chang-pai-shan radiates in three directions. Strategically the most important offshoot extends in a southwesterly direction to the end of the Liao-tung peninsula. The principal road across this range is the Imperial road, which, leaving the valley of the river Yalu, crosses by the Motien-ling (the Heaven reaching pass) and descends on Liao-yang. The road over the mountains is difficult and zigzagged towards the summit of the pass, which is about 4,000 feet above the sea.

As the mountains trend southwards they become lower and are traversed by several roads, such as those from Hsiu-yen to Hsi-mu-cheng and Haicheng, and still further south roads across the peninsula become numerous.

The range the Chang-pai-shan throws out to the north separates the valley of the river Sungari from that of the Mutan-chiang; while the third offshoot separates the valley of the latter from that of the Tumen river. These ranges are all crossed by roads, and in the case of the railway pierced by tunnels. The mountains are composed of granite, gneiss, felspar, and especially basalt. Lava is frequently met with near Ninguta. The mountains are precipitous towards the summit, densely clothed with timber, and much cut up by ravines.

RIVERS.

As regards the rivers, the Liao traverses the richest portion of the country. Though 650 miles in length, it is not navigable by fair-sized junks above Tie-ling, some 200 miles from the sea. The limit of navigation by sea-going junks is at the town of Tien-chuang-tai, 30 miles above the bar.

The treaty port of New-chwang* is 13 miles above the bar and is usually known by the name of Ying-k'ou. It is situated on a flat alluvial plain on the left bank of the river. The terminus of the New-chwang branch of the Russian railway is 2½ miles to the northeast of the European settlement. On the opposite side of the river is the terminus of the North China Imperial Railway. The trade of this port is very considerable. Japanese shipping heads the list with entries of 202,000 tons per annum, British shipping is a good second with 196,000, while that of all other nations amount to 71,000 tons. Eighty-five per cent. of the exports are beans, bean oil, and bean cake; the imports are chiefly cotton goods and yarn, sugar and kerosene oil.

Of all the affluents of the Liao the most important is the river Hun which passes about 3 miles south of the city of Mukden; but though this stream is largely used by flat-bottomed boats it is not navigable in the European sense of the word.

The Sungari is upwards of 1,000 miles in length, but is not navigable by steam launches above Kirin. From Petuna, however, fair-sized flat-bottomed steamers ply to Khabarovsk. The Nonni, which joins the Sungari from the north, is navigable by fair-sized boats as far as Mergen, while flat-bottomed steamers can reach the provincial capital of Tsi-tsi-kar.

The Amur is known to the Chinese as the Hei-lung-chiang or Black Dragon river. It is formed by the junction at Pokrovska of the Shilka and Argun rivers. The Shilka is geographically the more important, as it is a link in the river route from the Primorsk to the Trans-baikal province. As a rule the lightest draught steamers drawing 3½ feet cannot ascend beyond Stretensk, the terminus of the Trans-baikal section of the Siberian railway, which is 248 miles above the junction of the Shilka with the Amur. From Pokrovska to Blagoveschensk (544 miles) the Amur flows through cliffs and high wooded banks. The settlements are composed of wooden shanties; there is little or no cultivation, the settlers earning a poor livelihood by cutting fuel for the steamers in summer and hunting in winter.

From Blagoveschensk to Khabarovsk (609 miles) the river in ordinary years can be navigated by steamers drawing six feet of water; the contract time for the mails before the advent of the railway was 13 days from Khabarovsk to Stretensk (1401) miles), but when the river is low, this time is much exceeded. The river is closed by ice from the beginning of October to the middle of May.

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*The Chinese name of this city is Ying-tzu or Ying-k'ou, but as it is the port of the Chinese city of Niu-chuang, situated some 30 miles due north, it has erroneously been called New-chwang by Europeans. In order to prevent confusion it is customary to spell the name of the port in an Anglicised form, while the Chinese city is spelt Niu-chuang.

The Ussuri, a tributary of the Amur, is navigable from Iman about 253 miles from Khabarovsk.

The Tumen forms the boundary between Manchuria and Korea up to within 7½ miles of its mouth, whence it separates the Primorsk province from Korea. The river is full of rocks and boulders, navigation even at its mouth is difficult, it is consequently as a navigable river of little value.

The river Yalu, from its source to its mouth in the Yellow Sea, forms the frontier between Korea and Manchuria. In its upper reaches it traverses a wild forest country given over to hunters and men engaged in the lumber trade. This river is navigable by small junks for 50 miles, but steamers drawing about 13 feet can only just enter the mouth of the river.

The port of Ta-thung-kou at its mouth is largely frequented by native craft, principally engaged in the lumber trade. It is fronted by extensive mud flats. Sea-going junks can ascend about 20 miles to the city of Antung, commonly called Sha-ho-tzu, an active business town. The Russians claim to have obtained a concession from the Corean Government at Yong-am-pho, a port far superior to Ta-thung-kou. This village is on the left (Corean) bank and close to the mouth of the river. The deep water channel, carrying 3 to 5 fathoms at low water, is close to this bank of the river.

COAST LINE.

The coast of Manchuria measures some 600 miles in length, extending from the mouth of the River Yalu to the Great Wall at Shan-hai-kuan.

On the coast of the Yellow Sea are the minor ports of Ta-thung-kou and Yong-am-pho (above mentioned), Ta-ku-shan, and P'i-tzu-wo. The whole of the coast to within 20 miles of Ta-lien-wan is very shoal. The 5-fathom line is seldom within five miles of the coast, and not uncommonly at about double that distance, added to which the foreshore dries out in mud flats at low water for a distance of a mile or more. There is little or no shelter for ships except under the lee of some of the islands. Only one island, that of Hai-yang-tao, near which the battle of the Yalu was fought in 1894, possesses a harbor. This small harbor, called Thornton Haven, affords shelter for small vessels in 3½ to 4 fathoms.

The ports at the mouth of the Yalu and Ta-ku-shan are closed by ice between the end of November and the middle of March. In fact, wherever a port is situated on a river, it is closed by ice in winter; but where there are no fresh water streams, as at Ta-lien-wan and Port Arthur, it is only in the hardest winters that ice gives any trouble. In the gulf of Liao-tung there is only one harbor, that of New-chwang. Vessels drawing 17 feet can cross the bar, which is 13 miles below the city.

COMMUNICATIONS (ROADS).

There are in the European acceptation of the word no roads in Manchuria. There are well-defined tracks leading from city to city, but their condition depends entirely on the weather.

The rains fall in July and August and at times last into September. Cart traffic is then scarcely feasible, and generally speaking, it is not safe to trust the majority of the roads after the middle of July or expect them to be in fair order until the middle of September. Towards the end of November they become really good and continue so until the end of February, when the surface begins to thaw by day. In April the roads break up with the thaw, but again become dry and good in May and in June.

The nature of the soil, a friable loam, and the absence in most cases of stone near the highways, combine to render road-making far too expensive a luxury. There are probably some 4,500 miles of main trade routes in the country and an equal length of less important roads, not one yard of which is metalled, and a bridge is an exception.

The Government expends no money on the roads unless it is absolutely necessary, as in cutting zig-zags over passes, when soldiers are employed to do the work, which is undertaken for strategical reasons rather than to increase the facilities of trade.

The detours made by carts to avoid impassable bits in the road add considerably to the length of the journey, and are the cause of endless disputes with the farmers, who cut trenches to prevent the carts leaving the track, and it is little exaggeration to say that at times the labor bestowed on those trenches would, if expended on the road, make it passable. The chief roads are the Pekin Imperial road from the Corean frontier to Pekin through Mukden, 682 miles. The coast road from the Yalu to Port Arthur, 228 miles. Imperial road from Port Arthur to Kirin through Mukden, 557 miles, and another 613 miles on to Aigun through Tsi-tsi-kar.—Total 1170. Kirin to the frontier at Hunchun, 342 miles, and Kirin to Sansing, 337 miles.

RAILWAYS.

The main line of the Chinese Eastern Railway runs in a southeast direction across Manchuria, the distance from frontier to frontier measuring 943 miles.

At Sungari, close to the river of that name and 596 miles from the N. W. frontier, the Southern Branch leads in a southwesterly direction for a distance of 615 miles to Port Arthur.

For the first 580 miles from the Trans-baikal-Manchurian frontier, the railway, except where it pierces the Kinghan mountains, traverses a steppe country sparsely inhabited by Mongols, but as it approaches the valley of the Sungari, the character of the country changes. The valley is highly cultivated, and there are numerous large villages, approaching towns in size, and the new Russian City of Harbin. From Sungari the Southern Branch traverses the richest portion of Manchuria, passing through the great commercial city of Kuan-cheng-tzu (Ch'ang-ch'un) and thence down the valley of the Liao, the most fertile part of the country. From the head of the Liao-tung gulf, where a short branch connects it with the Treaty Port of New-chwang, it traverses the Liao-tung peninsula, a hilly country much cut up by streams and not very densely populated.

On the main line from Sungari to Vladivostok the railway traverses a hilly region, hitherto scarcely populated at all, partly on account of the country in the lowlands offering a more favorable opening to farmers, and due also in a measure to the fact that brigands formerly made this district their home. However, the presence of the railway has already made great changes in this district, and doubtless in time this region will support a large and flourishing population.

The railway is divided into sections of an average length of 94 miles, and sections again into stations with an average distance between them of 17 miles. Again, between stations are sidings at which trains can pass when going in opposite directions, at an average distance apart of 8½ miles. All sidings are made long enough to take two trains, so that trains can be run in pairs.

Bridges are of standard type, iron girders and stone piers, span 105 and 245 feet. The largest are near Tsitsikar, over the Nonni, 711 yards; two over the Sungari river, No. 1 bridge 1,038 yards, and No. 2 bridge 805 yards; and another near Mukden, over the river Hun, 700 yards. There are besides 11 bridges of 200 yards and upwards in length.

The tunnels are four in number, and all on the main line. The longest is that being now driven through the Khingan mountains, 3,115 yards in length; two others, 105 and 210 yards long, are situated 100 miles from the southeast frontier; and a third, 233 yards in length, close to that frontier.

It seems a remarkable fact that there is at present only one long tunnel on a railway running between Flushing and Port Arthur, traversing Europe and Asia from end to end for a distance of 7,000 miles. I say at present, because when the railway is taken round the south shore of Lake Baikal two or more tunnels of considerable length will be required; however, for the present, there is a break in the line of 40 miles across Lake Baikal, connection being kept up by steamers.

The permanent way is on the Russian gauge of 5 feet, the rails rather light, being some 62 lbs., and less in places, to the yard.

The first-class carriages are excellent, but owing to the necessity for heating apparatus and double windows, are rather heavy, about 25 tons, with sleeping accommodation for 50 passengers. The second weigh 18 tons, and the third about 15 tons. An average train is made up of 25 coaches. Trains in Russia, except the St. Petersburg-Moscow Express, have a journey speed of 16½ miles an hour, so when the Chinese Eastern Railway is complete in every respect, it is improbable that the journey speed will exceed that rate, that is, the journey from Moscow to Port Arthur will be made in just over 14 days. These figures refer to a train of some 25 coaches, and not to the limited express composed of a dozen or less carriages. Of course in a large continuous movement of troops, with necessary halts, a journey speed exceeding 12 miles an hour can scarcely be kept up, that is, the journey from Moscow to Port Arthur will, with two halts of 24 hours each, take about twenty days.

The strength of a chain depends on its weakest link, and there are in Siberia several heavy gradients, especially in the Trans-baikal section, where curves are sharp and the cuttings narrow.

To equip a railway, 5,415 miles in length, for a continuous movement of troops is a vast undertaking. Allowing an engine with a journey speed of 12 miles per hour to work for eight hours a day, 57 engines would be required to draw a heavy troop train from Moscow to Port Arthur, and to draw six trains each way would necessitate 855 locomotives, allowing engines for shunting, repair, and rendering assistance at steep gradients.

The cost of construction of this railway is not accurately known, probably it will not fall far short of 75 millions sterling. As a commercial venture it can scarcely pay for many years; but the value of a great national undertaking such as this cannot be appraised from a commercial point of view. One has only to consider the position of Russia in the Far East before this railway was built to realize how profoundly it has modified the strategical position of Russia on the shores of the Pacific. A few years ago the Russian Army in Eastern Siberia was for six months in the year cut off from European Russia just as completely as our army in South Africa would be if we were to lose the command of the sea.

The only other railway in Manchuria is the Chinese Imperial Railway of North China. It is of standard gauge. The terminus at New-chwang is on the right bank of the River Liao, which river separates it from the Russian railway. The branch to Sin-min-tun is now under construction. That town is 40 miles by road from Mukden.

The distance by this railway from New-chwang to Shan-hai-kuan is 217 miles, and to Tientsin is 423 miles.

—Extract from lecture by Col. G. F. Browne before the Aldershot Military Society.

Port Arthur.

Port Arthur, the second Russian military port in the Far East, consists of a narrow irregular harbor, the entrance to which past the Tiger's Tail is very crooked and so shallow that heavy warships can enter only at high water. Taking a large ship in or out is a difficult operation requiring care and sometimes as much as half a day's time. Very often, too, it happens that a ship will run aground and thus block the passage for a greater or less time.

The harbor consists of two parts: the eastern basin and western lying behind the Tiger's Tail. The former is the main port and consists of a large, rectangular stone basin capable of accommodating many large ships. There is a dry dock here, an 80-ton crane, arsenals, repair shops and fitting-out shops.

The western harbor is so filled in with sand that at low water a large part of the bottom is exposed. It was intended to dredge the larger part to a depth of 45 feet.

The town and harbor are surrounded by hills 650 to 985 feet high. The land fortifications, which extend around on the northern and partly on the northwestern side, at a distance from 2½ to 3 miles from the inner eastern basin, command all the hilly foreground of the fortress. These works form two lines, one extending from the coast northward to the railroad, the other, not so long, on the western side of the harbor. They are well located, are of excellent construction, and render the fortress, it would seem, secure from attack on the land side.

The coast batteries and works are situated on both sides of the entrance, and on the Tiger's Tail peninsula which separates the western harbor from the sea. The principal forts occupy commanding positions on the heights facing the sea, varying from 266 feet to 410 feet high. In most cases the older Chinese forts have served as foundations for the more modern works. These have been, however, thoroughly rebuilt according to modern plans, are well equipped and heavily armed, and may be considered, therefore, much more modern than some of Russia's European fortresses.

The works completed up to 1903 constituted, in the main, three large forts. The first is armed with eight 11.8-inch (30 cm.) guns and six 6-inch (15 cm.) guns; the second with eleven 11.8-inch and twenty-eight 6-inch guns; the third with twelve 11.8-inch and fifty-two 4-inch (10 cm.) guns. It is also known that the large fort commanding the entrance has seven Canet 5.5 cm. rapid-fire guns.

Some smaller works and a number of connecting points constitute the total of the fortification work up to the early part of 1903. All the group of works as well as the land fortifications are connected with one another by smaller works located on commanding points, thus forming a complete defensive system around the port. In the budget for 1903-04, 13 million rubles were appropriated for the fortifications at Port Arthur, including an extension of the works towards Dalny.

The Russian military press describe Port Arthur as an impregnable bulwark for Russia's position in the Far East. These new works and batteries erected by the Russians are excellently well built and most favorably situated to resist attack. Their armament as a whole includes 400 guns between 4.3-inch (12 cm.) and 11.8-inch (30 cm.) caliber. Having immense amounts of ammunition, supplies and equipment on hand, also a large artillery park and possessing the security of supply of good drinking water, it should be possible for the place to withstand a year's siege successfully.

On the other hand, English papers consider Port Arthur a shell-trap that could not hold out against attack and especially a massed attack by heavy guns from the sea-front. By such an attack the warehouses, supply depots, workshops, etc., in the city (they are not massively built) and all the ships lying in the harbor could soon be destroyed.

—*Mitth. Art. u. G.*, *Seewesens*, *Wochenblatt*, and other sources.

Notes on the War Between Russia and Japan.

With dramatic suddenness the negotiations between Russia and Japan with reference to their respective positions in the Far East, were broken off at the beginning of February; but with even more dramatic suddenness did the Japanese readjust the balance of naval power which for some months has been slowly but surely tending to Russia's favor.

With the diplomatic side of the question I am not here concerned. For an understanding of the situation it is merely necessary to bear in mind the disposition of the forces of the combatants in the early days of February. It was on the 5th of that month that the Mikado's government intimated to St. Petersburg that, their patience being exhausted, they must terminate negotiations with words, and appeal to the sword. It has since been learned that on or about that day the Japanese fleet, with the exception of a few small cruisers, was ordered to assemble at Sasebo, under the command of Admiral Togo. It is believed that six battleships, the Mikasa, flagship, Asahi, Fuji, Yashima, Shikishima, and Hatsuse, with six armored cruisers, the Asama, Yakumo, Azuma, Idzumo, Iwate, and Tokiwa, and at least eight protected cruisers with nineteen torpedo boat destroyers concentrated there.

The Russians, on the contrary, in defiance of all recognized tenets of strategy, distributed their fleet between three points, Port Arthur, Vladivostok and Chemulpo, knowing well that in the event of war, the vessels at the northern port could hardly hope to effect a junction with those in the Yellow Sea. At Port Arthur there were gathered the seven battleships, Retvisan, Cesarevitch, Poltava, Petropavlovsk, Sevastopol, Peresviet and Pobieda, with the armored cruiser Bayan, and the small cruisers Boyarin, Novik Askold, Diana and Pallada. At Vladivostok there were four powerful cruisers, the Gromovoi, Rossia, Rurik and Bogatyr, which could easily have left for Port Arthur at any time, as the harbor was kept clear of ice. And at Chemulpo were the cruiser Variag, and the old gunboat Korietz, neither of them of much use singly, but important intregal factors in the combined fleet. It is further to be noted that for some cause or another Port Arthur has ceased to be ice free in the winter, and the whole of the Russian fleet there, with the exception of the Sevastopol in dock, was forced to leave the inner waters

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hurriedly on January 29th, to avoid being locked up in the ice then forming, and to lie outside the breakwater.

Such, then, was the position of the opposed fleets on the first day (February 6th), that a state of war may be said to have been in existence. It would be foolish to suppose that Admiral Alexeieff was unaware of the dangerous position his fleet was in. If he did not know it, at least Vice-Admiral Stark did. But no steps were taken to put the fleet in the only safe place, the open sea. Whether those responsible acted on instructions from St. Petersburg or not is never likely to be known. The result was the same. A powerful fleet was left in an exposed position, no apparent steps were taken, such as would seem to be indicated by common prudence, and the Japanese found an easy prey.

For Admiral Togo had steamed into the Yellow Sea, followed by Admiral Uriu with the armored cruisers Asama and Chiyoda, the protected cruisers Takachiho, Naniwa, Suma, and Akashi, six torpedo boats, and several transports. It may be urged that the Japanese were strategically foolish to send out their transports before having established command of the sea. Had the two vessels at Chemulpo been a torpedo flotilla, as in the correct course of events they should have been, and had the Port Arthur fleet not remained cooped up at its moorings, the earliest engagements of the war would in all probability have made different reading. But the very daring and success of the maneuver shows that the Japanese had not miscalculated the probable action of their opponents.

In the forenoon of February 8th, according to the Japanese official information, Admiral Uriu's squadron met the Korietz as she was coming out of port, at Chemulpo. The Korietz took up an offensive attitude, and fired upon the Japanese torpedo boats, which replied with torpedoes, none of which took effect. It is not stated that Admiral Togo's fleet was then in sight. In all probability it was not. At any rate, neither of the Russian vessels could get out to carry the news to Port Arthur, and the consequence was the *débâcle* of midnight, February 8th to 9th. It is best described in the official dispatch sent by Admiral Alexeieff to the Emperor. In its very baldness it is more significant than columns of description :—

I most respectfully inform your Majesty that at about midnight on the night between February 8th and 9th Japanese torpedo boats made a sudden attack by means of mines (torpedoes) upon the squadron in the outer roads of the fortress of Port Arthur, in which the battleships Retvisan and Cesarevitch and the cruiser Pallada were damaged. An inspection is being made to ascertain the character of the damage. Details are following for your Majesty.

When the details came to be known it was at once obvious that the attack had been far more successful than even the first intimation had led us to believe. The Cesarevitch was damaged in her steering compartment, the Retvisan below the water line, and her pumping gear put out of order; while the damage to the Pallada was amidships, "near the engines." And since, up to the time of writing, it has not been found possible to get the Pallada into dock, it looks very much as if that "near the engines" was to read "in the engine room".

The following day the Japanese began a bombardment of Port Arthur, and in the course of the fight, which lasted about an hour, the battleship Poltava and the cruisers Diana, Askold and Novik were each damaged on the water line. The Russian losses were thirteen killed and fifty-four wounded. Admiral Togo, in a dispatch dated at sea, February 10th, states that his losses were four killed and fifty-four wounded, and the damage to the ships was slight. Subsequently, he reported the ships damaged were the Mikasa, Fuji, Yakumo and Iwate.

At about the same time as the bombardment of Port Arthur was proceeding, Admiral Uriu was engaging the Variag and Korietz outside Chemulpo. The result of the action was that both Russian ships returned to harbor badly damaged, where they were blown up by their crews, who escaped to the foreign vessels in the port, The Russian losses were 47 killed and 62 wounded. No casualties were reported from the Japanese side.

The torpedo flotillas which accompanied Admiral Togo were divided into two groups, one of which carried out the successful attack at Port Arthur, and the other of which appears to have gone to Dalny and drawn blank. This latter flotilla was not, however, quite deprived of an opportunity to distinguish itself, as on the night of February 14th—15th it was dispatched to Port Arthur to complete the work begun six days earlier. Owing, however, to a blinding snow storm, only two vessels succeeded in reaching the Russian fleet, the torpedo boat destroyers Asagiri and the Hayatori, One of these succeeded in torpedoing an enemy, believed to be the Boyarin, but also reported to be the Bayan. Either way, the exploit was a remarkable one, and in no way less useful than that which heralded the war.

Of the Vladivostok squadron, it is sufficient to note that it has been cruising in the Northern Sea of Japan, sunk an unarmed merchantman on February 11th, and threatened to bombard Hakodate, an unprotected port, both of them criminal actions, which will do little to advance the progress of the war, and much to damage Russia's cause with the other powers. On February 11th also the mining transport Yenessei struck one of her own mines, and was blown up with great loss of life.

On February 16th, the new Japanese cruisers Kasuga and Nisshin arrived at Yokosuka, the English officers who had assisted to navigate them before war was declared, being received and decorated by the Mikado personally.

On February 24th, the important news was circulated that Admiral Virenius and the squadron which had been lying at Djibutil for some weeks was ordered home.

The effect of the action at Port Arthur on the naval situation will be better understood from a study of the following tables :—

RUSSIA—FLEET IN THE FAR EAST.

Type	Vessel.	Date of Launch.	Displacement. Tons.	Speed. Knots.	Coal Capacity. Tons.	Principal Armament.	Wt. of Broadside. lb.
b	Peresviet	1898	12674	18.5	2056	4 10-in., 11 6-in., 20 3-in.	2672
b	Pobieda	1900					
b	Ossliabia*	1898					
b	Poltava	1894	10960	17.5	1050	4 12-in., 12 6-in.	3367
b	Sevastopol						
b	Petropavlovsk						
b	Retvisan	1900	12700	18	2000	4 12-in., 12 6-in., 20 3-in.	3434
b	Cesarevitch	1901	13100	19	1350	4 12-in., 12 6-in., 20 3-in.	3516
a.c.	Bayan	1899	7800	22	1100	2 8-in., 18 6-in., 20 3-in.	952
a.c.	Gromoboi	1899	12336	20	2500	4 8-in., 16 6-in., 20 3-in.	1197
a.c.	Rossia	1896	12200	20	2500	4 8-in., 16 6-in.	1348
a.c.	Rurik	1892	10940	18	2000	4 8-in., 16 6-in., 6 4.7.in.	1345
a.c.	Dmitri Douskio	1883	5893	15	400	5 6-in., 6 4.7-in.	444
p.c.	Askold	1900	6500	23	1100	12 6-in., 12 3-in.	772
p.c.	Variag	1899	6500	23	1250	12 6-in., 12 3-in.	510
p.c.	Pallada	1899–00	6630	20	1430	8 6-in., 22 3-in.	632
p.c.	Diana						
p.c.	Aurora*						
p.c.	Boyarin	1901	3200	22	650	6 4.7-in.	180
p.c.	Novik	1900	3000	25	600	6 4.7-in.	180
p.c.	Bogatyr	1901	6750	23	1430	12 6-in., 12 3-in.	872

* On passage out.

JAPAN—FLEET IN THE FAR EAST.

Type	Vessel.	Date of Launch.	Displacement Tons.	Speed Knots.	Coal Capacity. Tons.	Principal Armament.	Wt. of Broadside. lb.
b	Hatsuse	1899	15000	18	1400	4 12-in., 14 6-in., 20 3-in.	4240
b	Asahi						
b	Shikishima						
b	Mikasa	1900	15200	18	1500	4 12-in., 14 6-in., 20 3-in.	4250
b	Yashima	1896	12300	18	1100	4 12-in., 10 6-in., 20 3-in.	4000
b	Fuji						
a.c.	Tokiwa	1898	9750	21.5	1200	4 8-in., 14 6-in., 12 3-in.	3568
a.c.	Asama						
a.c.	Yakumo	1899	9850	20	1100	4 8-in., 12 6-in., 12 3-in.	3368
a.c	Azuma	1899	9436	21	—	4 8-in., 12 6-in., 12 3-in.	3368
a.c.	Idzumo	1899–00	9800	24.7	1600	4 8-in., 14 6-in., 12 3-in.	3568
a.c.	Iwate						
p.c.	Takasago	1897	4300	24	1000	2 8-in., 10 4.7-in., 12 3in.	800
p.c.	Kasagi	1897–98	4784	22.5	1000	2 8-in., 10 4.7-in., 12 3-in.	800
p.c.	Chitose						
p.c.	Itsukushima	1890–91	4277	16.7	400	11 2.5 in., 11 4.7-in.	1260
p.c.	Hashidate						
p.c.	Matsushima						
p.c.	Naniwa	1885	3727	17.8	800	2 10.2-in., 6 5.9 in.	1196
p.c.	Takichiho						
p.c.	Yashima	1892	4180	23	1000	4 6-in., 6 4.7 in.	780
p.c.	Akitsushima	1892	3150	19	—	4 6-in., 6 4.7-in.	780
p.c.	Niitaka	1902	3420	20	600	6-6-in.	920
p.c.	Tsushima						
p.c.	Suma	1895	270	20	200	2 6-in., 6 4.7-in.	385
p.c.	Akashi						

The immediate effect of the reverse to the Russians in the Far East was to set rumour active with regard to the Baltic and Black Sea fleets. The Black Sea fleet, it is quite permissible to leave altogether out of consideration in reference to the situation in the Far East. For not only are the vessels too old to be of much use out there, they are also of too small coal capacity to render it practicable to send them on the journey, even could permission be obtained to let them pass the Dardanelles. Much the same objection applies to the Baltic fleet, as will be seen from the following table:—

RUSSIA—FLEET IN THE BALTIC.

Type	Vessel.	Date of Launch.	Displacement. Tons.	Speed. Knots.	Coal Capacity. Tons.	Principal Armament.	Wt. of Broadside. lbs.
b	Sissoi Veliky						
b	Navarin	1894	8800	16	800	4 12-in., 6 6-in.	3099
b	Nicolai I.	1891	9476	16	1000	4 12-in., 8 6-in.	3172
b	Alekander II.	1889	9700	15.9	1200	2 12-in., 4 9-in., 8 6-in.	2292
b	Borodino	1889	9900	16.5	1200	2 12-in., 4 9-in., 8 6-in.	2292
b	Alexander III.						
b	Orel	1901–02*	13516	18	1250	4 12-in., 12 6-in., 20 3-in.	3456
b	Kniaz Suvaroff						
b	Slava						

* These vessels are completing, and will not be ready to leave till the late spring.

In all these tabular statements I have only taken into account the larger vessels. Small craft would be practically useless for the Russian purpose out there, even if they could get there, which is more than doubtful.

—*Page's Magazine*, March, 1904.

The Russo-Japanese Naval Actions.

In attempting to record the damage sustained by the belligerents up to date great difficulty is experienced on account of the many and various accounts which reach this country from the theatre of war. In more than one case, indeed, the evidence of so-called eye-witnesses has proved inaccurate. However, it appears possible from the mass of conflicting evidence to extract a certain amount of information about which there is general agreement. Such information is mainly based on the official records of either side, which from internal and other evidence appear trustworthy, supplemented by such unofficial accounts as agree in their main details and do not appear to be antecedently improbable. Beginning, therefore, with the Japanese torpedo boat attack at Port Arthur on February 8th, we know for a fact that three Russian vessels were torpedoed—the battleships Czarevitch and Retvizan and the protected cruiser Pallada.

Special interest attaches to the torpedoing of the first named, as she was specially strengthened below water against torpedo attack. The 4-inch longitudinal bulkheads associated with the armored deck ran from the stem of the vessel to just abaft the after magazine, and are carried down to the double bottom at the turn of the bilge. She appears to have been struck aft, however, and possibly so much so as to have cleared the rear extremity of the bulkhead. Her steering gear is reported damaged, and although she seems to have been docked, she is unlikely to take any further active part in the naval operations unless it be as a guard ship for the port. This is to be regretted, as she is a very excellent and typical example of the latest French ideas in naval construction, and it would have been most instructive to artillerists and constructors had she taken part in a fleet action, and could have been compared with the equally typical English built battleships in the Japanese fleet. She has a complete belt, mounts her secondary guns in pairs in turrets, having their bases protected by armored ammunition hoists, and has no side armor above the main deck. She should be practically unsinkable by gun fire, but is an admirable target for H.E. or common shell.

The Retvizan, which was apparently more seriously injured, is an American-built and designed ship of a different type, having a partial belt only, a 5-inch battery redoubt on the main deck, and with her upper deck guns in casemates. She has no under-water protection.

The Pallada,* about whose subsequent fate no reliable information is obtainable, was struck amidships, and it is probable that the earlier accounts which reported her sunk are correct.

On the 9th, the Japanese followed up their success of the night before by a fleet attack at long range, from 5000 to 6000 yards separating the opposing fleets, and apparently some 10000 yards intervening between the Japanese ships and the forts.

In this engagement the Russian ships Poltava, Diana, Askold and Novik were all put out of action, while on the Japanese side the armored cruisers Iwate and Yakumo—some accounts say the battleship Shikishima—were reported to have received slight injuries from shell fire. In contra-distinction to what occurred at Santiago water-line hits seem to have been frequent, all the above mentioned vessels being struck in this region, The Japanese are said to have used only their 12-inch and 8-inch guns, and they certainly did so with great effect.

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* According to the latest reports the Pallada is now in dock.

At 5000 yards' range, assuming an angle of impact of 30 degrees, these guns are capable of piercing, with A.P. shot, the following thickness of armor :—

Gun.	Wrought Iron.	Compound.	Harveyized Steel.	K.W.C.	K.C.
Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
12	20	15	12	10	8
8	7.5	6	4	3.5	3

As it is obvious that the 15-inch Harveyed belt of the Poltava cannot have been perforated, we must assume that her water-line was pierced at one of the unarmored ends. If the projectile which did the damage was a high explosive shell, it is probable that a very big hole was made, but even an 8-inch or 12-inch powder-filled common shell would do a lot of damage in this quarter.

In the case of the protected cruisers, whose sloped armored decks would be equivalent in resisting power to from 4-inch to 6-inch of steel, it is possible that the vitals were penetrated, if armor piercing shell were used. If, however, as is more probable, H.E. were used, the shells striking against the armored deck would blow large holes in the side plating. There can be no question but that against H.E. shell vertical side armor is of very much greater value than a sloped armored deck of equivalent weight, although the latter may be of more value against armor piercing projectiles. However, H.E. is what would be invariably used against a protected cruiser—or ordinary common in the case of heavy guns which might not fire H.E.—and it is this class of shell in particular which it is important to guard against.

In the action at Chemulpo, which was also fought at a very long range—from 4000 to 8000 yards—the Russians were greatly outnumbered. and the Japanese armored cruiser Asama alone would have been more than a match for her two opponents.

Here, again, accounts of what happened vary, one story being that the Variag was sunk by an 8-inch shell from the Asama, and according to another she was sunk by her own captain when he found himself unable to continue the action.

The Russians claim to have seriously injured the Asama, to have sunk a torpedo boat, and the old Japanese protected cruiser the Takachiho, but this has not been confirmed from other sources.

With regard to the reported torpedoing of the Boyarin on the 14th, the Japanese claim to have torpedoed a vessel, name unknown ; but, on the other hand, the Russians deny that any casualty was sustained on this occasion. However, a Russian report states that the Boyarin was seriously damaged about this time by a mine, and, in view of the fact that the Russian word for "mine" and "torpedo" appear to be the same, some color is lent to the report that this was the vessel torpedoed on the 14th ; it was certainly not the Bayan, as one daily paper had it. The latest reports from both combatants mention the Bayan, Askold and Novik as having engaged the enemy on the 25th—the morning after the daring Japanese attempt to "cork the bottle." It is evident, therefore, that the Askold was not sunk on the 9th, as previously reported, and also that neither she nor the Novik were seriously injured on that occasion. On the other hand, the Retvizan is still beached, and nothing has been heard of any of the Russian battleships since the action on the 9th. The Yenesei, blown up by one of her own mines on February 11th, was a special mining vessel—one of two recently completed for the Russian navy. Although a non-combatant, her loss is a serious one.

On both sides sundry torpedo craft have been sunk or injured. Some surprise has been expressed at the so-called attacks by the Japanese fleet on the Russian land batteries. Obviously, however, the only objects of these attacks has been either to cover attacks by the torpedo flotilla, or else to demoralize the garrison and inhabitants generally by a long range bombardment. At the range at which the ships appear to have engaged the forts, they have run little risk of being damaged themselves, while, on the other hand, it has been easy for them to lob shell into the large area covered by the town and dock yard, and although they cannot have hoped for any great material effect, the moral effect of such continued harassing must inevitably be considerable.

LIST OF INJURED VESSELS.

RUSSIAN CASUALTIES.

Torpedoed at Port Arthur, February 8th, 1904.

BATTLESHIPS.

CZAREVITCH, built at La Seyne; completed 1902; 13110 tons; 16300 I.H.P.; nominal speed 18 knots.

Armament.	*Armor.*	
Guns—	Belt 10-inch and 2½-inch.	K.C.
Four 12-inch (in two turrets)	Decks 4-inch and 2-inch.	K.C.
Twelve 6-inch (in six turrets)	Lower deck side 6-inch.	K.C.
Twenty 3-inch.	Heavy gun turrets 11-inch.	K.C.
Torpedo tubes—	Heavy gun bases 10-inch.	K.C.
Six (two submerged)	6-inch gun turrets 7-inch.	K.C.
	6-inch gun hoists 6-inch.	K.C.
	Conning tower 11-inch.	K.C.

N.B.—This ship has two longitudinal 4-inch bulkheads associated with the armored deck, and reaching down to the double bottom for protection against torpedo attack.

RETVIZAN, built at Philadelphia; completed 1902; 12700 tons; 16000 I.H.P.; 18 knots nominal speed.

Armament.	*Armor.*	
Guns—	Belt 9-inch (admidships)	K.C.
Four 12-inch (in two turrets)	Deck 3-inch.	K.C.
Twelve 6-inch (4 in casemates, eight in battery)	Lower deck side 6-inch.	K.C.
	Turrets 10-inch.	K.C.
Twenty 3-inch.	Turret bases and Bulkheads 9-inch.	K.C.
Torpedo tubes—		
Six (two submerged)	Casemates and Battery 5-inch.	K.C.
	Conning tower 10-inch.	K.C.

PROTECTED CRUISER.

PALLADA, built at St. Petersburg; completed 1902; 6630 tons; 11600 I.H.P.; nominal speed 20 knots.

Armament.	*Armor.*
Guns—	Deck 2½-inch steel.
Eight 6-inch.	Gun hoists 2½-inch steel.
Twenty-two 3-inch.	Conning tower 6-inch K.C.
Torpedo tubes—	
Four above water.	

Damaged by gun-fire at Port Arthur, February 9th, 1904.

BATTLESHIP.

Poltava, completed at St. Petersburg, 1898; 10960 tons; 10600 I.H.P. (forced draught); nominal speed 17 knots.

Armament.

Guns—
  Four 12-inch (in two turrets)
  Twelve 6-inch (eight in four turrets, four in casemates).
  Sixteen 3-inch.
Torpedo tubes—
  Six (two submerged)

Armor.

Belt (part) 15-inch Harveyed steel.	
Deck 3½-inch steel.	
Bulkheads 9-inch.	H.S.
Lower deck side 4-inch.	H.S.
Heavy gun turrets 10-inch.	H.S.
Heavy gun bases 6-inch.	H.S.
Small turrets 6-inch.	H.S.
Small bases 5-inch.	H.S.
Casemates 5-inch.	H.S.
Conning tower 9-inch.	H.S.

PROTECTED CRUISERS.

Askold, completed at Kiel, 1901; 6500 tons; 19500 I.H.P.; nominal speed 23 knots.

Armament.

Guns—
  Twelve 6-inch.
  Twelve 3-inch.
Torpedo tubes—
  Six (two submerged)

Armor.

Deck 2-inch.	Steel.
Hoists 1½-inch.	Steel.
Funnel bases 1½-inch.	Steel.
Torpedo tubes 2⅓-inch.	Steel.
Conning tower 6-inch.	K.C.

Diana, sister to Pallada.

Novik, completed Danzig, 1902; 3000 tons; 18000 I.H.P.; nominal speed 25 knots.

Armament.

Guns—
  Six 4.7-inch.
Torpedo tubes—
  Five (all above water)

Armor.

Deck 2-inch.	Steel.
Engine hatches 3-inch.	Steel.
Conning tower 1¼-inch.	Steel.

Reported torpedoed February 14th, 1904, Port Arthur.

PROTECTED CRUISER.

Boyarin, 3200 tons; 11500 I.H.P.; nominal speed 22.5 knots.

Armament.

Guns—
Six 4.7-inch.
Torpedo tubes—
  Five (all above water)

Armor.

Deck 2-inch.	Steel.
Conning tower 3-inch.	Steel.

Destroyed in action off Chemulpo, February 9th, 1904.

PROTECTED CRUISER.

Variag, completed at Philadelphia, 1900; 6300 tons; 20000 I.H.P.; nominal speed 23 knots.

Armament.

Guns—
  Twelve 6-inch.
  Twelve 3-inch.
Torpedo tubes—
  Four (two submerged)

Armor.

Deck 3-inch.	
Conning tower 6-inch.	K.C. (?)

GUNBOAT.

KORIETZ, completed at Stockholm, 1887 ; 1500 tons ; speed 10 knots.

Armament.

Guns—
- Two 8-inch.
- One 6-inch.
- Four 4-inch.

Sunk at Port Arthur, February 11th, 1904.

MINING TRANSPORT.

YENESEI, 2500 tons ; speed 16½ knots.

JAPANESE CASUALTIES.

Slight damage reported done by shell fire to the armored cruisers Iwate and Yakumo on February 9th, at Port Arthur.

IWATE, built at Elswick, 1900 ; 9800 tons ; 14500 I.H.P. ; nominal speed 21 knots.

Armament.

Guns—
- Four 8-inch (in two turrets)
- Fourteen 6-inch (ten in casemates, four behind shields)
- Twelve 3-inch.

Torpedo tubes—
- Four submerged.

Armor.

Belt 7-inch and 3½-inch.	K.C.
Deck 2½-inch.	Steel.
Lower deck side 5-inch.	K.C.
8-inch gun turrets and bases, 6-inch.	K.C.
6-inch casemates, 6-inch.	
Conning tower (?)	K.C.

YAKUMO, built at Stettin, 1899 ; 9850 tons ; 16000 I.H.P. ; nominal speed 20 knots.

Armament.

Guns—
- Four 8-inch (in two turrets)
- Twelve 6-inch (eight in casemates, four behind shields)
- Twelve 3-inch.

Torpedo tubes—
- One above water.
- Four submerged.

Armor (Harvey Nickel and Krupp.)

Belt 7-inch and 3½-inch.
Deck 2½-inch.
Lower deck side 5-inch.
8-inch turrets and bases.
6-inch casemates, 6-inch.
Conning tower (?)

BOOK REVIEWS.

The Tactical Employment of Quick-firing Field Artillery. Translated from the French of Gabriel Roquerol, Major in the 16th Regiment of Artillery, by Captain P. de B. Radcliffe, R. F. A. 16 + 233p. maps. D. London: Hugh Rees, Ltd., 124 Pall Mall, S. W. 1903. 6 shillings net.

Major Roquerol's book well deserves to be read, especially by field artillery officers. With the introduction of the new rapid-fire material, questions of its properties, its resulting fire tactics and proper employment present the greatest interest. In this book they will find the views of an extremely able artillery tactician put forth in a most interesting as well as instructive manner.

Though the adoption of rapid-fire field guns by all the Powers is now, as regards material, beginning to be an accomplished fact, the question of how to use such material is still the order of the day. It is this question which forms the subject of this work. Confronted with the problem of the conflict of opinions in regard to the employment of this new gun, the author to appreciate the stability of principles and doctrine goes back to their origin and traces their birth. He shows that the rapid-fire gun brings with it no revolution but a development. But it is the application of principles that constitutes the art of war, and this *application* becomes gradually modified in proportion to improvements in armaments. He has had recourse to history, accordingly, and by successive deductions applies first principles to the equipment now in use.

The data actually available is taken as the basis of the study, that is, the conditions essential to the practical service of the gun, as also the effects produced by its fire, and the characteristics of the different types of guns now in use furnish the elements for discussion.

In Part I. the principal characteristics of the quick-firer are concisely given, followed by a chapter on its fire effect in which are discussed the various natures of projectiles and their employment. Part II. on the fire tactics of artillery is important. The principle, development and employment of the "rafale" are here set forth in a most interesting fashion. The "registered area", the "rafale" or "shell storm" and the very important factor in the efficiency of artillery fire, surprise, are shown to be of the first importance if the new weapon is to make the most of its powers. The action of artillery behind cover, in the open, service practice and action against various objectives, based on the principles thus developed, concludes this part.

Two short chapters on artillery on the march and in camp are followed by Part IV., to which the remaining half of the book is devoted. This part consists of six chapters and treats fully of "employment of artillery in the fight". It embodies the latest principles in regard to the use of artillery in battle, and must be read in its entirety to be fully appreciated. We must content ourselves with recommending this, and the whole book in fact, to artillery officers and those interested in this fascinating subject.

Finally, remark must be made of the excellence of the translation. Captain Radcliffe has evidently well mastered his subject, is in sympathy with the *thoughts* of the author, and expressing them in well rendered English, gives us a translation that is entertaining and agreeable reading from beginning to end.

Zur Technik des Schiessens der Artillerie gegen Ziele in Bewegung auf Grund der Schiessregeln. Hauptmann Wilhelm Knobloch, Lehrer in der k.u.k. Schiessschul-Abtheilung der Festungs-Artillerie. Wien: L. W. Seidel & Sohn. 1902. Pp. 36.

Captain Knobloch's essay is an important contribution to the method of using field, mountain, siege and fortification artillery against moving targets: Although based more particularly on the Austrian firing regulations, the article has considerable general application, because it is a discussion of principles as well of technical matters, and will be found useful in any army.

Practical Field Exercises in Tactics and Strategy. For the use of the Regular Army and the Militia. By John P. Wisser, Major Artillery Corps, U. S. A. 265p. maps. O. 27 maps, separate case. Kansas City: Hudson-Kimberly Publishing Co. 1903. Blue Cloth, $2.00.

Now that our yearly maneuvers have been established and in view of the interest aroused in practical field exercises and maneuvers by those that have thus far been held, this book appears very opportunely. It will commend itself to military students both of the Regular service and the Militia as a means of preparation for such work and of testing their ability to handle troops tactically in the field.

The author's interest in the subject dates from 1884, but in addition to these years of study he has also had considerable experience as an instructor in courses of exercises and lectures on minor tactics. Impressed with the value and importance of field exercises in increasing the practical ability of officers, he presents in this work an excellent system of instruction and training that should do much towards inspiring greater interest in the subject and enable those who are willing to study and perfect themselves in the art of troop-leading to acquire this tactical knowledge.

In time of war, face to face with the real thing on his first battlefield, what will a commander do who has not studied the conduct he should pursue? Will he trust to inspiration? It would be risky; the faculty of inspiration is the perquisite of few, and it has further been said with some truth to be the result of lightning calculations based on previous study. Hence the method presented deals entirely with practice and approaches reality as closely as is possible in time of peace, the direct object being to sharpen the intellect and assist in reaching decisions quickly and accurately so that officers may direct their troops and carry out their orders intelligently, properly and promptly.

In the text the system of practical field instruction is first explained and this is illustrated by several examples. Chapter I. gives the analysis of the system: the use of lectures, dictation, exercises in the field, and a general discussion of a typical problem, in regard to statement, including the general and special situation, solution and execution and the order of procedure, finally comment and criticism. The author gives some sound advice about such exercises in general and his remarks on the statement and solution can hardly be improved upon.

Then follow one hundred problems, progressive both in scope and character, some solved according to accepted principles, others left unsolved for the student to take up under proper guidance. The solutions given are merely designed to indicate the manner of procedure, and are not to be considered as the only possible solutions under the circumstances, nor as the author states, " even the best ". But they are able and realistic and well serve the purpose in view. The problems illustrate the most common and also the most important duties of troops in the field, comprising the service of security and information, the tactics of the three arms separately and combined, and various special services. They are arranged under the different arms of the service to which they pertain, beginning with the simplest in each section and gradually leading up to the more difficult and complicated.

The maps, on some of which some of the problems are worked out in detail, are sheets of the Geological Survey, folded and contained in a separate binding case uniform in size with the book. The arrangement is convenient and satisfactory for individual use and study as well as for the discussion of any problem by any number of officers.

Major Wisser works along the same lines as the leading European authorities in this field, and his book is a useful and welcome addition to our military literature. It can be studied with profit and affords interesting suggestions to those whose duty it may be to set problems for field maneuvers and camps of instruction.

Strategy. A lecture by Colonel Arthur L. Wagner, Assistant Adjutant-General, U. S. A. 55p. O. Kansas City: Hudson-Kimberly Publishing Co. 1904. Blue Cloth, 75 cents.

The subject-matter of this book consists of a lecture that was delivered by Colonel Wagner to the officers of the regular army and national guard at the maneuvers at West Point, Kentucky, and at Fort Riley, Kansas, in 1903. We have read it through with considerable pleasure and consider that it is one of the clearest and most interesting discussions of the subject that has come to our attention.

The author disclaims being able to compress within the limits of a single lecture "a subject which would require many volumes for its proper elucidation"; nevertheless, he has well succeeded in presenting probably well known facts in a new grouping, and in bringing out in strong relief the underlying principles of the art of strategy.

After considering the various definitions of strategy, the essential simplicity of its principles—all great things human are essentially simple, the difficulty is to attain the requisite simplicity—he goes at once to the vital question of supply and shows how strategical operations are affected—in fact, regulated—by this paramount consideration. The illustrations of the application of this principle include quotations from the history of our own and foreign campaigns. The author notes the potency of the railroad and telegraph as factors in producing strategical changes under modern conditions, also the effect of the press. Finally, he briefly considers the qualities of the strategist and how they differ from those of the tactician, comparing in this respect the qualities of great commanders of modern wars.

The language is clear and forcible and the book is profitable as well as interesting reading. It can be recommended to the attention of all officers of the service.

Report of the Chief Umpire, Maneuver Division. West Point, Kentucky, and Fort Riley, Kansas, 1903. Colonel Arthur L. Wagner, Assistant Adjutant-General, U. S. A. 257p. il. maps. D. Kansas City: Hudson-Kimberly Publishing Co. 1904. Paper, 75 cents.

This report, published by authority of the War Department, embraces a detailed account of the problems given for solution and of the operations of the troops of the maneuver division, and contains an abundant amount of information in regard to the maneuvers held last year at Camp Young and Camp William Carey Sanger.

An interesting feature of the report is the comments at the end of each problem. They are clearly and impartially expressed, pointing out the errors made in the execution of the problems and those dispositions meeting with approbation. Furnished by one who is fully competent to judge, these comcomments, together with the solution of the problems as executed, furnish instructive material for study as a means of preparation for future maneuvers.

Colonel Wagner considers that the maneuvers at West Point furnished a thorough practical test of the suitability of the ground for military purposes and demonstrated that the region in question is admirably adapted to use as a maneuver-ground.

The maneuvers at Fort Riley are treated in the same manner. The problems with full description of their execution are given, followed by comments in each case. Finally, General Comments, which conclude the book, touch interestingly on many considerations relating to the general subject of maneuvers: their immense practical value and advantage both to regular troops and the national guard, provisions for future encampments, and discussion of points brought out by the maneuvers. They include many strong recommendations in regard to improvement in the conduct of future maneuvers, to equipment, and some minor features, all suggested by the experience thus far had.

Several illustrations and two excellent maps, one of West Point and the other of Fort Riley, accompany the text.

The book is of interest and will prove valuable to officers both of the regular army and of the national guard.

The Military Law Examiner. By Lieut.-Colonel Sisson C. Pratt, R. A. (retired). Ed. 5. 16+192p. D. London: Gale & Polden, Ltd. 1903. 4 shillings and sixpence.

This is a useful handbook for the British service, containing a series of questions and answers on Military Law. They are methodically grouped in sections which are sufficiently comprehensive to cover the subject thoroughly.

There are twenty-nine such sections, as, for example, history of military law, military code, military custody, powers of commanding officer, jurisdiction, composition and procedure of courts-martial, punishments, crimes, evidence, courts of inquiry, etc., to mention some among several other heads.

The questions have been selected with care, are well arranged and are answered with clearness and brevity. As the author states, it is well to remember that as a general rule a long answer is a wrong answer.

The book is especially well adapted not only for enabling officers to prepare themselves for examinations but also for training themselves in the knowledge of how their military code is applied practically in the daily routine of camp and garrison.

Taschenbuch der Kriegsflotten. V. Year 1904. Edited by B. Weyer, Kapitanleutnant a D. 341p. 311 plans and pictures of ships. S. München: Verlag von J. F. Lehman. 1904. Blue Cloth, Mk. 3.

The 1904 Naval Pocket-book closely resembles its predecessors in general arrangement and appearance, with the addition of some improvements both in the text and in the pictures of ships. Its chief value, naturally, is as a record of the German fleet and naval establishment, nevertheless it is a very satisfactory manual for other navies as well, for it contains a large amount of technical information well arranged for ready reference.

A few extracts in regard to new constructions may be of interest. In the German fleet two new battleships appear, "N" and "M", and two new ones "O" and "P", are to be laid down in 1904. "M" is bracketed with the Braunschweig class, while "N" seems to be the first of a new class, although the main particulars given are identical with those of the Braunschweig. In the large cruisers, the Ersatz Deutschland, building, is classed with the Roon, 9500 tons, an armored cruiser similar to the Prinz Adalbert only larger. One new armored cruiser of greater speed will be laid down in 1904. Of the small cruisers the most recent are five in number: The Berlin, Hamburg and Bremen have been launched and two are building. Three new ones are to be laid down in 1904. These cruisers are improved types of the Gazelle, being larger and faster (3000 tons, 22 knots) but somewhat more lightly armed. One torpedo boat division is to be built in 1904.

In France we notice one armored cruiser, "N" 13650 tons, planned for 1904, with armament of four 24 cm., twelve 16.5 cm., twenty-two 4.7 cm., and two 3.7 cm. guns. Japan is given three projected battleships, 18000 tons, according to the program of 1903, three armored cruisers of 11000 tons and two of 5000 tons; also one small cruiser, the Otawa, of 3000 tons, now building. Russia is credited with two 16630 ton battleships building in the Baltic and two of 12700 tons in the Black Sea. Of cruisers, two of the Oleg and Bogatyr class, 6780 tons, are building in the Baltic, and two of 6800 tons similar to the Kagul, in the Black Sea.

There is a fund of other information on the navies of the world contained in these tables. The rest of the book, statistical information, comparative tables, conversion tables, naval artillery, etc., is the same as last year with such revision as may have been necessary to bring the matter up to date.

The comparative diagrams appeal to the eye, but we doubt the reliability of the method of arbitrarily assigning twenty-five years as the "life" of a battleship and basing conclusions thereon. Moreover, it would appear much too long judging from the great advances made in naval science and architecture these days.

On the whole this is an excellent little book and constitutes a convenient and useful work for all interested in naval matters.

EXCHANGE AND BOOK NOTICES.

The **Aldershot Military Society** sends us the following lectures, which were delivered before the Society. They are interesting and repay reading.

75. Manchuria, by Colonel G. F. Browne, late Military Attaché in China.

76. Naval and Military Co-operation in War, by Commander G. F. Ballard. R. N.

77. "The People's War;" a synopsis of two lectures delivered by Colonel Lonsdale Hale, late R. E.

78. The Evolution of Modern Infantry Tactics, by Lieutenant-Colonel F. N. Maude, late R. E.

These lectures are published by Hugh Rees, Ltd., 124 Pall Mall, S. W., London.

E. S. Mittler und Sohn publish as a supplement to **Marine-Rundschau** a series of pamphlets on the Russo-Japanese war. Five numbers have thus far appeared which cover thoroughly the events on both land and sea up to and including March 11th. In addition to description and discussion of the actions and movements of the opposing forces, the account treats of the general situation, the strength and organization of the opposing forces military and naval, the question of neutrals and contraband of war, etc., and contains a large amount of information on various places in the theatre of operations. Maps, sketches and diagrams accompany the text.

The handsomest map of the theatre of operations of the war in the Far East that we have seen is that published as a supplement to the **Rivista di Artiglieria e Genio** for February. This is a large topographic map about 21 x 26 inches, lithographed in six colors. It is very complete in regard to the names of places and other features, and possesses the advantage of great distinctness. Six smaller maps show the details of the principal harbors.

In its issue of March 5th, 1904, the **Electrical World and Engineer** celebrates its thirtieth anniversary with a most interesting number of over 280 pages in which the editors have been able to bring together a large volume of personal recollections and data of many of the men who have been thinkers and workers during the period of marvelous electrical development between 1874 and 1904. These articles cover all the great inventions of the period, give a great deal of personal history of the events connected with the evolution and development of modern telegraphy, the telephone, the arc-light, the incandescent lamp, the electric motor and other branches, and many of them present facts under new illumination. Written by such well-known captains as Edison, Tesla, Sprague, Coffin, Griffin, Kennelly, Bell, Anthony,—to name but a few—they form a series of contributions of unique permanent value for all who may be interested in this art which has seen such wonderful and unparalleled expansion during the past thirty years.

The Engineering Magazine for March 1904 is an especially attractive and interesting number devoted to labor saving by power applications. Its contents include the following: The World's Great Labor Savers and Labor Servers, fully illustrated with portraits of famous engineers and inventors. Its special theme is the development of steel making—a matter which the author justly says lies at the foundation of all modern expansion in the engineering industries.

Some of the other notable articles are:

The Effects of Labor saving Machinery; The Prime Mover and its Influence on the World's Progress, with many illustrations showing the development of the steam engine. Hydraulic Power Appliances in Engineering Industries; Labor-saving Machinery in Foundry Operations; Development of Power-Driven Machinery in the Mine; Mechanical Auxiliaries to the Economy of the Fire room; The Relation of Electric Inventions to Human Activity.

The Marine Review beginning with its issue of March 10 appears in a new and enlarged form. The size and make-up of the page has been changed slightly, the cover is new, so that the result is an attractive improvement in every way. The Review covers a wide field, drawing interesting matter from many sources, and will be found an interesting well-arranged and useful publication on everything pertaining to ship building matters.

Rifle Shooting Made Easy is the title of a small book published by Gale & Polden, Ltd, that has been specially compiled for members of civilian rifle shooting clubs by a Musketry Instructor. It appears at an opportune moment in these days of rifle clubs, and to follow the hints contained therein will materially help those who desire to attain proficiency in marksmanship.

The mechanism of the British Service rifle and sights, the care of the rifle, rules for aiming, targets, on the range, scoring, etc., are the headings of some of the chapters. The instructions given are clearly and concisely expressed, and the book is a thoroughly practical one.

Sketches and diagrams accompany the text and a glossary of terms used in shooting is given at the end of the book.

On and after the April issue the title of **the Index of the Technical Press** will be altered to "**The Engineering Press Monthly-Index Review.**"

The change of name is being effected on account of the important modifications that are to be introduced in this publication, in view of which its former title but inadequately suggests its scope.

Encouraged by the success that the Review has already achieved, the publishers have decided, commencing with the April number—the first issue of the second year of publication—to introduce certain improvements of a character that are sure to be appreciated. To begin with, in deference to the wishes of numerous subscribers, and for facility of reference, etc., the size of the publication will be changed. In future, the size of the page will be nearly doubled. In addition to about 2,000 résumés monthly the Index will contain a review of *the* engineering question of the month as well as extended notices or summaries of the most remarkable articles and papers of the month, appropriately illustrated—it will, in fine, be a review of reviews of the engineering Press.

INDEX TO CURRENT MILITARY LITERATURE.

[For Abbreviations used in Index see first number of each *volume*.]

[Periodicals of December, 1903, January, February, 1904.]

ARTILLERY MATERIAL.

Guns, projectiles and their effect.—**Ueberall**, 14, 15.
Moulding and casting a steel carriage for the 24 cm. Ordonnez mortar.—**M. de Art.**, December.
Progress in explosives since the development of organic chemistry.—**Umschau**, January 16.
Testing caps or detonators in the laboratory.—**Mines & Min.**, February.
German percussion fuze 96 for explosive shell.—**R. Artillerie**, November.
Remarks on the "Development of aiming apparatus for field artillery."—**Wochenblatt**, 139, 1903.
Development of recoil and counter-recoil apparatus for long recoil field guns.—**Int. Rev. Suplmt.**, 58.
New field artillery, U. S.—**A. Marine**, January 31.
Draft and firing tests of rapid-fire field guns.—**M. de Art.**, December.
New Swiss field gun.—**Proc. R. A. I.**, July–Sept., 1903.
Mountain artillery equipments and establishments.—**Proc. R. A. I.**, July–Sept., 1903.
Rearmament of the field artillery, Holland.—**Kriegstech.**, 2, 1904.
Armament of the Russian and Japanese forces.—**A. Marine**, March 6.
The new field gun carriage, England.—**Arms & Expl.**, January.
Note on the embarkation of artillery material of large calibre.—**R. Artillerie**, November.
Armor.—**R. de Mar.**, December.
Description of a miniature artillery range.—**Proc. R. A. I.**, July–Sept., 1903.
Special slide rules for armor perforation formulas.—**Proc. R. A. I.**, October–December, 1903.
Modern sights.—**R. de Mar.**, December.
The panoramic telescope.—**Scien. Amer. Suplmt.**, February 6.
Naval artillery.—**A. Marine**, January 17; **R. Maritt.**, February.
Rock Island Arsenal.—**Jour. U. S. Cav.**, January.
The naval gun factory.—**Iron Age**, January 14.
Ordnance in our Navy, U. S.—**A. & N. Jour.**, February 27, March 5.
Streaked metal in guns.—**A. & N., Jour.**, March 5.

AUTOMOBILES, AEROSTATION.

Balloons and balloon service of the German army.—**Ueberall**, 6.
Utility of spherical balloons.—**A. Marine**, February 7.
Aerostation and foreign coast defense.—**A. Marine**, January 3.
Dr. Greth's dirgible airship.—**A. Marine**, January 3.
Employment of kites at sea.—**Seewesens**, 4, 1904.
Aerial navigation,—**M. de Art.**, January; **Pop. Sc. Mo.**, March.
Field balloon service.—**Wochenblatt**, 14, 15.
The "Barton" airship.—**Page's Mag.**, January.

Elihu Thompson on aeroplanes.—**Elec. World**, February 6.
Automobile developments.—**Page's Mag.**, January.
Automobile construction.—**Amer. Mach.**, January 28, February 18.
Petrol motor car and wagon.—**Eng'ing**, February 12.
Petrol motor for motor cars.—**Eng'ing**, February 12.
Mechanical road traction.—**Eng. Mag.**, March.
Automobile truck with motors in the wheels.—**West. Elec.**, February 20.
Diplock's pedrail.—**West. Elec.**, February 27.
Motor car tires and springs.—**Eng.**, February 26.
The State and automobiles.—**Kriegstech.**, 1, 1904.
Progress in automobiles in 1903.—**Genie C.**, January 16, 23, 30.
Colonel Renard's automobile train.—**Umschau**, March 5.
Motor cars in Paris,—**Eng.**, January 8, 15, 22.
Manufacture of automobiles.—**Scien. Amer.**, January 9.

BALLISTICS, RANGE FINDING AND POINTING.

Determination of the velocity of projectiles by means of non-periodic condenser discharges.—**Mitth. Art. u. G.**, 12, 1903.
Notes on Bashforth's method of determining v and K_v.—**Proc. R. A. I.**, July-Sept., 1903.
Notes on exterior ballistics.—**Boletin**, January.
Ballistic apparatus.—**Mitth. Art. u. G.**, 1, 1904.
Illustrations and explanations of new range tables.—**Mitth. Art. u. G.**, 2.
Calculations of cordite rifle ballistics.—**Arms & Expl.**, February.
Automatic method for regulating the range for rapid-fire batteries.—**R. Artillerie**, November.
New method for using the Goulier telemeter by a single observer.— **R. Artillerie**, November.
Indirect pointing for field batteries using auxiliary aiming points.—**M. de Art.**, December.
Artillery fire in campaign.—**M. de Art.**, January.
Method of concentrating the fire of dispersed guns.—**Proc. R. A. I.**, July-Sept., 1903.
Indirect methods of aiming af the Italian field artillery.—**Organ**, lxviii, 1.

CHEMISTRY AND PHOTOGRAPHY.

The commercial derivatives of nitrocellulose.—**Genie C.**, January 9, 16, 23.
Radium, preparation and properties.—**Genie C.**, January 16, 23.
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Stability tests for nitrocellulose and nitrocellulose powders.—**Scien. Amer. Suplmt.**, January 2, 9, 16.
Combined development and fixing.—**Photo. Jour.**, January.
Use of instantaneous photography for the study of fire arms.—**M. de Art.**, January.

DRILL REGULATIONS, MANEUVERS, PRACTICE.

Some wishes regarding field artillery regulations.—**Wochenblatt**, 135, 1903.
The technical drill problem of the field artillery development,—**Wochenblatt**, 142, 1903.
Plan for the instruction of artillery scouts.—**M. de Art.**, December.
Artillery drill regulations, field and coast.—**Jour. M. S. I.**, March-April.
Field artillery drill.—**Wochenblatt**, 2, 1904.
The new French cavalry firing regulations.—**R. Univ.**, January, February.

Extract from preliminary draft of provisional field service regulations, U. S. Army.—**Jour. U. S. Cav.**, January.
New infantry drill regulations, Austro-Hungary.—**R. M. Etrang.**, January.
Consultation of the military authorities on the new infantry small arms regulations.—**Belgique M.**, January 24, 31; February 15.
Draft of regulations for infantry drill and maneuvers.—**R. Inf.**, December, January.
Study on the provisional infantry drill regulations.—**R. Inf.**, December, January, February.
Draft of the infantry and Jaeger musketry instructions.—**Organ**, lxviii, 1.
New firing regulations for small arms, U. S.—**A. & N. Jour.**, March 19; **A. & N. Reg.**, March 19.
Balloon drill regulations.—**Wochenblatt**, 9, 1904.
English army maneuvers, September, 1903.—**Ueberall**, 2, 1903-04.
Fleet maneuvers of the British navy.—**Ueberall**, 2, 1903-04.
English naval maneuvers, 1903.—**Seewesens**, 2, 1904.
English maneuvers in the Atlantic, August, 1903.—**Rundschau**, January.
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Austro-Hungarian maneuvers.—**Ueberall**, 4, 5.
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French grand autumn maneuvers, 1903.—**Ueberall**, 3, 4.
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Grand Swiss maneuvers, autumn, 1903.—**Ueberall**, 7, 8.
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Swiss army: attack and defense of a fortified position.—**Cercle**, January 9.
Maneuvers of the I. corps, 1903, Swiss—**R. M. Suisse**, January.
South African cavalry maneuvers.—**Proc. R. A. I.**, October-December, 1903.
Training and maneuvers in the Ottoman army. **Wochenblatt**, 13, 1904.
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Colonel Wagner on the maneuvers.—**A. & N. Reg**, February 6, 13, 20.
Results from the school of practice (field artillery firing).—**M. de Art.**, January.
Principles governing prize firing in the Royal garrison artillery.—**Proc. R. A. I.**, October-December, 1903.
Service prize firing and efficiency for service in the garrison artillery.—**Proc. R. A. I.**, October-December, 1903.
Battery trials at Lexdal, Norway, August, 1903.—**Wochenblatt**, 11.
Results of firing with long recoil guns, system Ehrhardt.—**Kriegstech.**, 2.
Italian cavalry in the water (swimming horses).—**Ueberall**, 2, 1903-04.
The need of practical work for cavalry.—**Jour. U. S. Cav.**, January.
Battle problems at infantry inspections.—**Wochenblatt**, 135, 1903.
Methodical training of the eye.—**Wochenblatt**, 140, 1903.
Judging distance.—**U. Serv. Mag.**, February.
Infantry training.—**Wochenblatt**, 8, 1904.
Prize firing and some comments.—**Eng.**, February 26.

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Telephone transmitters.—**Elec. World**, January 2-16, February 27, March 12.
Recent advances in space telegraphy.—**West. Elec.**, January 26.

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Telephone engineering.—**Amer. Elec.**, February, March.
U. S. Army wireless telegraphy.—**Elec. World**, February 27.
Transmission of electric energy without wires.—**Elec. World**, March 5.
Rapid cable testing.—**Tel. Mag.**, March.
Efficiency of modern telephone equipment.—**Amer. Elec.**, January.
Submarine cables and the Russian-Japanese war.—**A. Marine**, March 6.
Latest developments in wireless telegraphy.—**Umschau**, February 27.
Electrical installations in armored forts.—**R. Genie M.**, January.
Electricity anemometry in the sea coast artillery service.—**Elec. Rev.**, March 19.
A convenient method of mounting carbon resistances.—**Phys. Rev.**, January.
Electrical conductivity of commercial copper.—**Trans. Inst. Elec. E.**, November.
Review of electrical matters for 1903.—**Elec. Rev.**, January 9.
Coil windings for electrical purposes,—Elec. Rev., February 13; West Elec., February 20.
Rectifiers.—Elec. Rev., February 27.
Graphic recording-ammeter.—**Trans. Inst. Elec. E.**, November.
Series and parallel operation of generators.—Eng. C., January 15.
Comparative behavior of floating and boosters-controlled batteries on fluctuating loads.—Trans. Inst. Elec. E., November.
Modern developments in rotary converters.—**Elec. Rev.**, January 16.
Care and management of storage batteries.—**Elec. Rev.**, January 23, 30, February 6, 13, 20, 27.
Speed regulation of direct-current motors.—**Eng. C.**, January 1.
Testing large alternators.—**Elec. World**, January 2.
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Double-current generators and double-current supply.—**West. Elec.**, January 30.
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Repulsion type of alternating current motor.—**Elec. World**, February 6.
A practical primary battery.—**Scien. Amer.**, February 13.
Operation of storage batteries and boosters.—**Amer. Elec.**, January.
A new English storage battery.—**Elec. World**, February 6.
Exploring apparatus for accumulators.—**Tel. Mag.**, March.

ENGINEERING, FORTIFICATIONS.

Work of the French engineer troops in China, 1900-1901.—**Mitth. Art. u. G.**, 12, 1903.
New method of calculation for armored concrete, and application to recent tests.—**R. Genie M.**, January.
Work of the topographical engineers in France in the 19th century.—**R. Genie M.**, January.
The manufacture and use of concrete.—**Page's Mag.**, January.
A government cement-making plant.—**Eng'ing News**, February 25.
Tests of the adhesion and initial stress of steel in concrete.—**Eng'ing News**, March 10.

Construction and use of concrete steel piles in foundation work.—**Eng'ing News**, March 10.
Lateral earth pressures and related phenomena.—**Proc. A. S. C. E.**, March.
Land mines.—**Kriegstech**, 1, 1904.
Field fortifications according to Russian plans.—**Mitth. Art. u. G.**, 2, 1904.
Defense of intrenchments by the Turks in 1877-78, with results.—**Wochenblatt**, 15, 16, 1904.

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Boiler-room practice.—**Amer. Elec.**, February.
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Power of boilers.—**Eng. C.**, January 1.
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Combustion engines.—**Eng. C.**, January 15, February 1, March 1, 15.
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Recent developments in gas engines.—**Amer. Manfr.**, February 18.
American internal combustion engines.—**Amer. Elec.**, January.
Mietz & Weiss two-cylinder marine kerosene engine.—**Iron Age**, January 28.
Steam pipes and their connections.—**Eng. C.**, February 1.
Results of tests made in engineering laboratories: steam.—**Tech. Quart.**, December, 1903.
Superheated steam for steam engines.—**Cas. Mag.**, January.
The Curtis steam turbine.—**Eng'ing**, February 5.
Riedler-Stumpf steam turbines.—**Eng'ing**, February 12.
The Terry steam turbine.—**Iron Age**, March 17.
The steam turbine.—**Page's Mag.**, February.
Steam turbines.—**Proc. R. A. I.**, July-Sept., 1903.
Lubricating oils.—**R. Maritt.**, February.
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A new mechanism.—**Amer. Manfr.**, January 7.
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Some new manganese bronzes.—**Iron Age**, January 28.
Thermite—an invaluable agency for repairs.—**Mar. Rev.**, January 14.
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Strength and structure of cast iron.—**Stahl u. Eisen**, January 15.
Physical structure of metals and alloys.—**Jour. Eng. Soc.**, December.
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A new metal—nodium.—**Amer. Mach.**, February 18.

The widening uses of steel castings.—**Cas. Mag.**, February.

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The proportion of nickel for nickel steel.—**R. Maritt.**, January.

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Constitution and properties of silicon steel.—**Scien. Amer. Suplmt.**, February 6.

Recent investigations and discoveries in cast iron.—**Jour. Frank. Inst.**, February.

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German opinions on the power and vulnerability of England (her military ports, harbors, naval stations, lines of communications, etc.)—**Marine F.**, October, November.

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Manchuria: its strategical importance.—**R. de Mar.**, January.

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Suggestions for a large naval port, Argentine.—**Boletin**, November-December.

The great harbors of northwest Europe.—**Ueberall**, 3.

Works of improvement at Bizerte.—**A. Marine**, January 24.

New Admiralty works at Dover.—**Page's Mag.**, February.

The central Mediterranean.—**R. Maritt.**, December.

Russia, Japan, China, Korea.—**Can. Gaz.**, January 12.

The development of Bombay Harbor.—**Eng.**, February 19.

MILITARY HISTORY.

History of artillery: France.—**R. Univ.**, January, February.

Origins of the French cavalry.—**R. Cav.**, December, January.

History of the Prussian pioneers.—**Wochenblatt**, 3, 4, 5.

History of the cavalry of the army of Northern Virginia.—**Jour. U. S. Cav.**, January.

Studies on the South African war, 1899-1900.—**R. M. Etrang.**, January.

Napoleon chief of the army, Ulm.—**Cientifico**, November 15.

Characteristics of the French army under Napoleon.—**Wochenblatt**, 139; 11, 12, 1904.

The French cuirassiers.—**A. Marine**, January 10.

Waterloo.—**U. Serv. Mag.**, February.

Nelson and Napoleon—a criticism of sea power.—**Proc. R. A. I.**, July-September, 1903.

Blockade of Brest, 1803-1805.—**R. Maritime**, December, January.

Preliminaries of the organization of 1906.—**R. Mil. Portugal**, December 31.

Medical service of the Invincible Armada.—**R. G. de Marina**, January.

Frederick the Great as Commander-in-Chief from Mollwitz to Leuthen.—**Beiheft zum M. W.**, 3, 1904.

French railways under German management during the war of 1870-71.—**Int. Rev. Suplmt.**, 58.

The English Thibet expedition over the Himalayas.—**A. S. M. Zeit.**, February 13.

Campaign in China, May to September, 1900.—**R. Univ.**, January.

Observations on the war in South Africa.—**Jour. R U. S. I.**, January, February.

Spanish-American war in the Philippines.—**R. Maritime**, December, January.

An episode of the war of Secession; New Madrid and Island No. 10.—**Cientifico**, December 1.

Battle of Woerth.—**Wochenblatt**, 142, 143, 1903.

Studies of military history: Franco-Spanish invasion of Portugal, 1807.—**Exercito**, January.

Campaigns against India from the West and through Afghanistan.—**Jour. R. U. S. I.**, January, February.

Storming of the Hohenburg in Lemberg, 1648.—**Organ**, lxviii, 1.

The Japanese-Russian war.—**Belgique M**, February 15, 21; **A. Marine**, February 21, 28; March 6, 13.

Considerations on the Russian-Japanese war.—**Seewesens**, 4, 1904.

The Russo-Japanese war.—**R. Maritt.**, February; **Yacht**, February 13, 20; **Wochenblatt**, 22, 23.

The Eastern war.—**A. & N. Gaz.**, February 20.

Japan and Russia.—**U. S. Gaz.**, February 20.

War! The Russo-Japanese crisis.—**Eng'ing**, February 12.

Japan and Russia at war.—**R. of Rev.**, March.

The Russo-Japanese naval actions.—**Eng.**, March 4.

The war in the Far East.—**U. Serv.**, March; **A. & N. Jour.**, February 27, March 5.

MILITARY SCHOOLS.

A visit to the Swiss infantry school of musketry.—**Wochenblatt**, 140, 1903.

The military technical academy, Berlin.—**Kriegstech.**, 1, 1904.

Compulsory national military education.—**U. Serv. Mag.**, February.

Military education.—**Jour. R. U. S. I.**, January.

Requirements of War College U. S.—**A. & N. Jour.**, January 30.

The Russian naval school and the naval academy at Nicolaieff.—**A. Marine**, February 7.

The French Upper Naval School.—**A. Marine**, February 14.

The Naval Academy at Annapolis.—**A. Marine**, January 3.

Training of Japanese naval officers.—**Eng'ing**, March 4.

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The heavy artillery of the German field army.—**A. S. M. Zeit.**, December 5.

Reorganization of the Russian field artillery.—**Wochenblatt**, 141, 1903.

Rapid-fire field material and the reorganization of our field artillery.—**Exercito**, January.

Present state of field artillery rearmament among the European armies.—**Exercito**, January; **R. M. Suisse**, January; **A. & N. Jour.**, February 6.

Reorganization of the field artillery, Switzerland.—**R. M. Suisse**, January.

The Italian artillery in 1903.—**R. Artillerie**, November.

Machine guns in the German army.—**A. Marine,** January 24.

Hanoverian engineer corps.—**Kriegstech,** 1, 1804.

German field telegraph troops.—**Ueberall,** 15, 1904.

Organization of military field telegraph services.—**A. Marine,** February 14.

Mounted troops.—**Jour. M. S. I.,** March-April.

American cavalry.—**Wochenblatt,** 17, 1904.

Mounted riflemen (bicyclists).—**Kriegstech.,** 2, 1904.

The British army, 1903.—**A. & N. Jour.,** January 30.

A national army.—**U. Serv. Mag.,** February.

The future of the volunteers.—**U. Serv. Mag.,** February.

The mounted companies of South Oran.—**R. Inf.,** December.

The German army : the officer.—**R. Cav.,** January.

Short service training of reserve officers on the German system.—**Jour. R. U. S. I.,** February.

Esprit de corps—how it may be strengthened and preserved under the present organization and method of promotion, U. S.—**Jour. M. S. I.,** March-April.

Adjutant-General's office, U. S.—**A. & N. Jour.,** January 30.

General Staff methods, U. S.—**A. & N. Reg.,** January 9.

The army as a constructive force.—**A. & N. Jour.,** January 30.

Military administration in the field.—**R. Mil. Portugal,** December 31.

New organization of military transport in Russia.—**Wochenblatt,** 136, 1903.

Remounts.—**Belgique M.,** January 24, 21, February 7, March 6.

New regulations for the remount service for the Russian cavalry and artillery.—**R. M. Etrang.,** February.

The sanitary corps of the French army.—**Jour. Mil. Surg.,** January.

Expansion of the hospital corps in war.—**Jour. Mil. Surg.,** March.

Proposed army medical corps and medical reserve corps, U. S.—**Jour. Mil. Surg.,** March.

Medical department increase.—**A. & N. Reg.,** February 20.

Food hygiene of the soldier.—**Cercle,** January 16, 23, 30.

Military matters in Germany.—**A. S. M. Zeit,** December 12, 19.

The Corean army from a Russian point of view.—**Wochenblatt,** 138, 1903.

Russian forces in the Extreme East.—**Belgique M.,** February 15, **A. S. M. Zeit.,** February 13.

War power of the British empire.—**Ueberall,** 15, 16, 1904.

The Austro-Hungarian army.—**A. Marine,** February 7.

The Russian army.—**A. Marine,** February 14.

The Russian army of to-day.—**U. Serv. Mag.,** February.

The Chinese army.—**Jour. R. U. S. I.,** January.

The military situation in the Far East.—**Marine F.,** November.

Military notes on organization, etc., of the principal powers.—**Int. Rev.,** January.

The Japanese army.—**Umschau,** January 9; **R. M. Etrang.,** February.

The military forces of Japan.—**R. de Mar.,** January.

Japan's military position.—**Wochenblatt,** 2, 3, 4, 5; **Belgique M.,** February 7.

Russia's military strength in the Far East.—**Wochenblatt,** 6, 1904.

The Russian cavalry.—**Jour. U. S. Cav.,** January.

Military forces of Japan.—**Jour. U. S. Cav.,** January.

Report on Japanese army.—**A. & N. Reg.,** February 20.

Australian naval and military defense.—**U. S. Gaz.,** January 2.

Naval policy of Canada.—**Can. Gaz.,** January 12.

Navy estimates, England.—**Eng'ing.**, March 4.

New admiralty scheme of training: officers of the English navy.—**R. Maritime**, December.

Promotion of naval officers.—**Ueberall**, 6.

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Proposed new regulations for promotion and retirement.—**Boletin**, November-December.

Reorganization of the engineer corps in the German navy.—**Ueberall**, 3.

French naval budget for 1904—**Ueberall**, 6, **Marine F.**, October; **Seewesens**, January.

Annual report Secretary of the navy, U. S., 1902-03.—**Rundschau**, January, February.

Importance of auxiliary ships in naval warfare.—**Seewesens**, 1, 1904; **Int. Rev. Suplmt.**, 58.

Operations beyond the sea (transport, embarking, disembarking, etc.)—**R. Maritime**, January.

England and the command of the sea in the Mediterranean.—**Rundschau**, February.

SMALL-ARMS AND EQUIPMENTS.

Comparison of the Russian and Japanese rifles.—**Belgique M.**, February 24.

Armament of the Russian and Japanese forces.—**A. Marine**, March 6.

The Japanese 6.5 mm. rifle, model, 1897.—**Mitth. Art. u. G.**, 2, 1904.

Browning automatic pistol, cal. 9 mm.—**A. Belge**, November-December.

Disappearing (falling) targets.—**Kriegstech.**, 2, 1904.

New Browning automatic shot gun.—**Arms & Expl.**, March.

Ballistic properties of smokeless powders (especially with reference to small arms).—**Arms & Expl.**, March.

Straightening of rifle barrels.—**Amer. Mach.**, February 25.

Army ammunition for the government rifle.—**S. & Fish.**, March 10.

Saber vs. revolver.—**A. & N. Reg.**, February 13.

Physical properties of smokeless powders (small arms).—**Arms & Expl.**, February.

Signalling devices on rifle ranges.—**S. & Fish.**, February 18.

New uniform for the marine corps.—**A. N. Jour.**, March 19; **A & Reg.**, March 19.

The new helmet in the French army.—**Wochenblatt**, 142, 1903.

STRATEGY AND TACTICS.

Considerations on a Japanese-Russian war.—**Ueberall**, 7, 10.

A French plan of defense.—**Wochenblatt**, 141, 1903.

Development of strategic knowledge in the 19th century.—**Wochenblatt**, 145.

The offensive and defensive plans of the Japanese.—**Cercle**, January 30.

Evolution of modern strategy.—**U. Serv. Mag.**, February.

The theater of war between the Rhine and the Seine and the principal problems with regard to its fortifications.—**Mitth. Art. u. G.**, 1, 2, 1904.

Some problems presented by the introduction of Q.F. guns for field artillery. —**Proc. R. A. I.**, October-December, 1903.

Communication between artillery units in action.—**Proc. R. A. I.**, October-December, 1903.

Artillery in action—formerly and at the present time.—**R. Artillerie**, January.

Rapid-fire guns and progressive fire.—**Wochenblatt**, 7, 14, 1904.

In favor of field howitzers.—**Wochenblatt**, 8, 9, 10.

Tactical employment and training of the French field artillery.—**Wochenblatt**, 17, 1904.

Influence of the adoption of the new field guns on field artillery fire.—**A. Belge**, November.December.

The employment of machine guns.—**Kriegstech.**, 2, 1904.

Cavalry on the field of battle.—**R. Mil. Portugal**, December 31.

The new doctrine in the French cavalry.—**Wochenblatt**, 138, 1903.

Cavalry raids.—**Int. Rev. Beiheft**, 47.

The cavalry of the future.—**R. Cav.**, December.

Cavalry machine guns.—**R. Cav.**, December.

The new doctrine in the French cavalry.—**R. Cav.**, December.

Successive lines in cavalry tactics.—**Wochenblatt**, 1, 1904.

Cavalry tactics in the time of Frederick the Great and modern times. —**Wochenblatt**, 10, 11.

Some German ideas on tactics.—**U. Serv.**, March.

Infantry long-distance firing in the South African war.—**Wochenblatt**, 138.

Volley firing and individual fire.—**Cercle**, January 23, 30.

Do the lessons of the South African war make a change in our infantry drill regulations (tactics) appear desirable?—**Beilage, A. S. M., Zeit.**, 1, 1903.

Replenishment of ammunition of infantry on the firing line.—**R. M. Suisse**, January.

The advance of infantry under fire.—**R. Inf.**, February.

Mounted infantry.—**R. Inf.**, February.

Development of infantry fire tactics.—**Organ**, lxviii, 1.

Tactical problem.—**Cercle**, January 9.

The breaking off (withdrawal from) battle.—**R. M. Etrang**, February.

Tactical employment of large units according to the new Italian regulations. **R. M. Etrang**, February.

Tactical notes.—**R. Inf.**, December.

Tactics of the English after the South African war according to their latest regulations.—**R. Inf.**, December, January.

Crossing of columns on the march.—**R. Inf.**, January.

The tactical effectiveness of ships' artilllery.—**Seewesens**, 1, 2, 1904.

Note on naval artillery.—**R. Maritt.**, December.

Cruiser warfare.—**R. Maritt**, January.

Squadron evolutions and the tactics of modern fleets.—**Boletin**, January.

SUBMARINES, TORPEDO BOATS, WARSHIPS.

Submarine boats.—**Zeitschr. I. A. V.**, January 8.

Submarines in the United States.—**A. Marine**, January 3.

The "omniscope" for American submarines.—**A. Marine**, January 17.

The U. S. submarine boat Protector.—**Seewesens**, 4, 1904.

Development of the submarine in the direction of increased scope.—**Scien. Amer. Suplmt.**, December 24, January 2.

History and value of the submarine.—**Can. Gaz.**, February 23.

Torpedoes and battleships.—**Ueberall**, 12.
The torpedo in war.—**S. Serv. Mag.**, February
H. M. S. Amethyst.—**R. G. de Marina**, January.
H. M. S. small cruiser Berlin.—**Ueberall**, 2, 1903-04.
River gunboat Vaterland.—**Schiffbau**, January 13.
Austrian battleship Erherzog Karl.—**Eng.**, January 22.
New constructions for the German fleet.—**Int. Rev.** Suplmt., 58.
The French navy in 1903.—**Yacht**, January 2, 9.
Armored cruiser Sully.—**A. Marine**, January 24.
Mobile defenses of our naval bases.—**Yacht**, January 2.
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Creation and development of the modern Italian navy.—**R. G. de Marina**, January.
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Turbines for scout ships.—**Iron Age**, February 4.
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Gun trials of the Henry IV., Kleber and Desaix.—**Marine F.**, October.
New constructions, France. (battleships, cruisers, torpedo boats, etc.)—**Marine F.**, November.
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A general view of the modern navy.—**R. G. de Marina**, January.
Warship construction of the principal Powers.—**Int. Rev.** Suplmt., 58; **Ueberall**, 15, 1904.
Foreign navies in 1903.—**Yacht**, January 16, 33.
The two new Japanese warships, Kasuga and Nisshin.—**Yacht**, January 16; **Ueberall**, 15; **Eng.**, January 22; **Mar. Rev.**, February 11, March 24; **Scien. Amer.**, January 23.
Naval notes on construction and armament.—**Page's Mag.**, January, February.
A new type of battleship.—**Seewesens**, 4, 1904.
The effect of gun-fire on modern warships.—**Proc. R. A. I.**, July-September, 1903.
Armored cruisers.—**Rundschau**, January.
Test of battleship's turrets.—**Mar. Rev.**, March 3.
Beginning of ironclad construction.—**Mar. Rev.**, January 21.
Merchant ship and naval construction, 1904.—**Mar. Rev.**, January 21.
Chilian battleship Libertad (a very full and complete description, with numerous illustrations.)—**Eng.**, January 15.
The world's naval strength.—**Cas. Mag.**, March.
Comparison of the Libertad and other battleships.—**Mar. Rev.**, February 4.
The Japanese navy.—**Scien. Amer.**, February 13.
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The extreme east: Russia and Japan.—**A. Marine**, January 3.
Comparative statement of the Russian and Japanese sea forces in the Far East.—**Rundschau**, February.
The Russian navy in the Far Fast.—**Yacht**, February 13.

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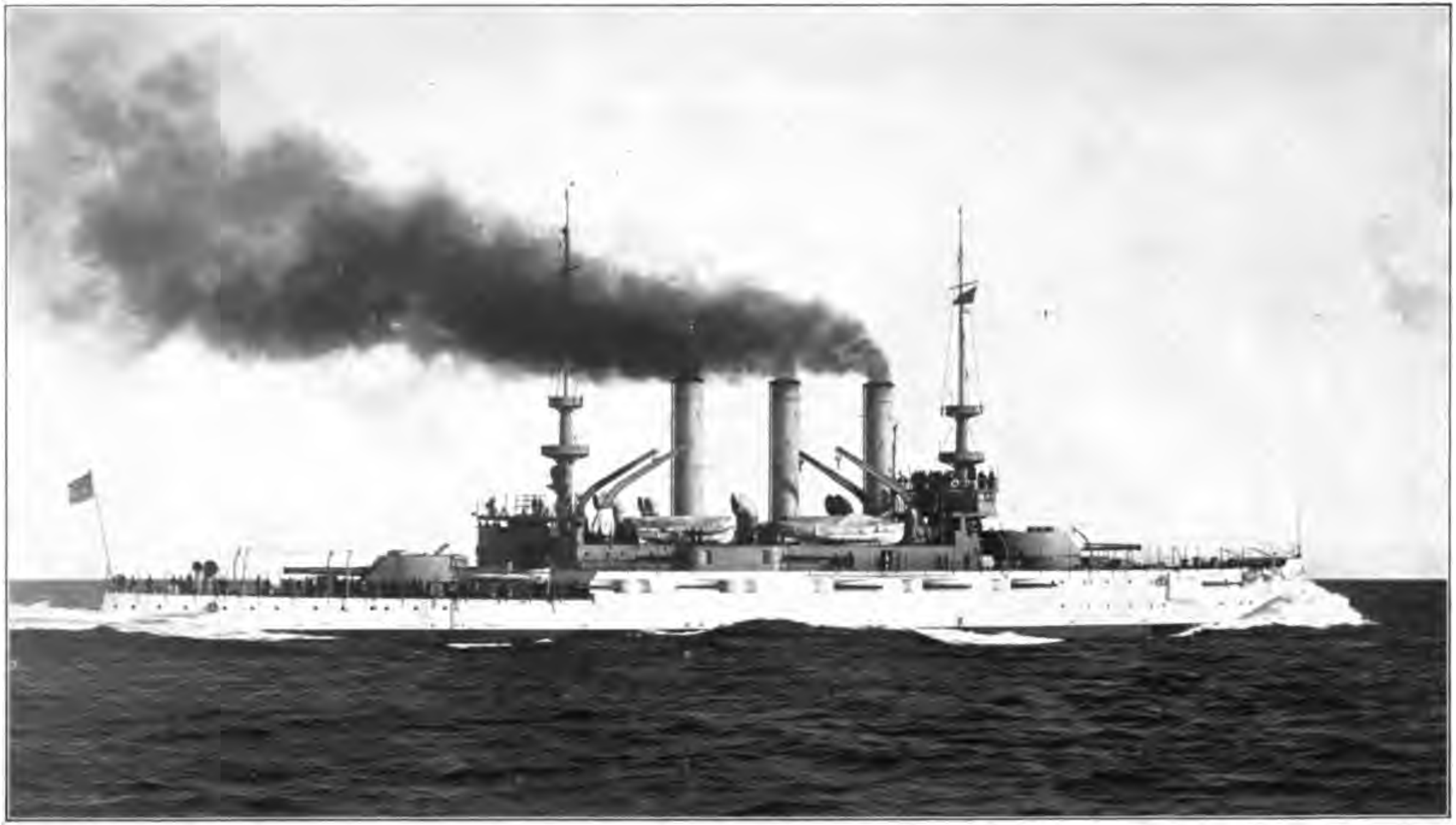

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THE OTHER SIDE.

BY CAPTAIN OLIVER L. SPAULDING JR., ARTILLERY CORPS.

For a long time we have read in the JOURNAL and elsewhere, of the shortcomings of the old regimental organization of the artillery. That organization has now been abolished, and we have been working as a corps for over three years. All the current publications dealing with the matter have dwelt only on the merits of the new as compared with the old.

Now that we all know something about the new, suppose we look over the ground again ; suppose we reverse the process and and consider for a time the merits of the old and the deficiencies of the new, which, though never published, have been noted by us all from time to time ; then, summing up, let us see whether or not we have made a mistake in abandoning the old system instead of reforming it—for that it had serious defects and sadly needed reforming I will admit at the outset. And let us also consider what reforms were necessary.

First, what were the principal faults found with our old organization, which led to its abandonment ?

1. First and foremost, it was said, the regiment was useless as a tactical unit and clumsy as an administrative unit. A cavalry or infantry regiment is an efficient unit for both purposes, but an artillery colonel could never hope to exercise actual

control over his whole regiment, leaving the organization without a *raison d'être.*

This is a substantial objection, and if it cannot be avoided the regiments can not hope to make out a case. It really comprises two objections—one to the organization of the regiment, one to the way in which it was handled. It certainly was not *used* as a tactical unit: I have in mind one case where, without apparent necessity, parts of three regiments were mixed together into a heterogeneous mass; instances of mixing two will occur to almost any officer.

For this mixing there was some excuse, in the unwieldiness of the old regiment, especially after the organization of batteries N and O; but could not some way be found to make the regiment a workable tactical unit?

That some tactical unit was necessary goes without saying; the first step taken after abolishing our old and unwieldy unit was to establish a new one, the district. This, in itself, is an excellent unit; wherever practicable, it comprises only posts which naturally belong together, it is usually compact, it is always handy in size. Of course, the principle of unity has to be violated occasionally, to avoid having some districts too small and others too large. Thus Forts Constitution, Rodman, Caswell, are attached to districts to which they do not naturally belong; and the defenses of New York, being so extensive, have had to be divided into two districts. But the unit remains the best so far devised.

So, as to this objection, we must admit its force as applied to the old system, and conclude that if a regimental organization is to be made workable, the regiments must be smaller than the old ones, and they must be capable of being fitted into territorial districts.

2. The old organization had no head, and concerted action was not attainable.

This is quite true, of course. A chief of artillery was needed, and securing one was a long step in advance; but this is not an argument against a regimental organization. Let us have our artillery corps, with a chief at its head, by all means; but that corps might as properly be an aggregation of regiments as an aggregation of companies.

More, in omitting the intermediate organization, the regiment, we violate the principle of decentralization which is more and more strongly insisted upon nowadays in military matters. For example, consider our own recent re-adoption of the territorial division, or the recent establishment by Great Britain of permanent army corps, more or less on Continental lines. The artillery district occupies, but hardly fills, the place of the regiment in this aspect.

3. It was pointed out that batteries were frequently detached from their regiments, and had to be treated for many purposes as separate bodies. This objection is much the same as the first one discussed; the trouble was generally due either to the unhandy size of the old regiment, or to a failure to co-ordinate the work of the whole artillery, and distribute it properly among regiments. With smaller regiments, adapted to a territorial distribution, and a chief to direct, such instances would be exceptional; no more to be counted on than in other arms of the service. A company of the 9th Infantry has been in Peking since 1900, thousands of miles from the rest of the regiment; everywhere troops and companies are serving detached from their own regiments, under command of officers of other regiments and even of other arms; but no one suggests a cavalry or infantry corps.

4. The old heavy battery never fitted the fortification to which it was assigned. True, and neither does the present coast company. The authority exists, however, for varying the strength of the company to suit local conditions; the same authority could have been given for the heavy batteries of the regiments.

These, I think, are all the important objections urged against the old organization. What, now, are the advantages claimed for the new?

1. Companies, it is said, can be more or less localized; the trouble and expense of moving troops, property and records is saved, and companies become familiar with the particular weapons they are to use.

Companies do, indeed, seem to be localized; traveling expenses are undoubtedly curtailed; but this is only a slight saving. On the other hand, I for one, and doubtless most officers, know of good men who leave one company and re-enlist in another for that very reason, sometimes forfeiting a warrant to do it. They find the town or the climate not to their liking, or they simply grow restless; they know their company won't move, so they do. As often as not, they are lost to the artillery, or perhaps to the service altogether. The result is, the company changes very rapidly, and the advantage of localization vanishes for the enlisted men. For officers, it does not exist at all, since officers change station rapidly, and no company keeps the same set of officers long. If a man knew his regiment was to change station at some fairly well settled time, he would be more likely to re-enlist and stay by his old associates. The minority who want to stay in the same place always could be taken care of by transfers is so desired.

2. Officers' service is equalized, being governed by a roster in the office of the chief of artillery. This is true; but if regiments, as bodies, changed station at the end of a fixed time, the same result would be accomplished about as well, since the chief could still regulate detached service, etc. Further, this very rotation destroys the chief incentive to an officer to put his heart into his work; every time he changes station he takes an entirely new set of men, loses time learning their good and bad points, never does become as well acquainted with them as he did when he belonged to his battery and moved with it, and knows that if he finally does get worked into thorough harmony with his command, he won't be allowed to keep it.

3. We now have what we formerly lacked, a tactical unit, the district. This point has already been discussed above; a full statement of it is found in the JOURNAL for January and February, 1903, on page 4, an extract from which is given below. Reading this with the idea in mind of a regiment so organized that it garrisons a territorial district, we find our regimental commander naturally performing the same duties there laid down for a district commander; but with the added advantage of a more stable personnel and a regimental esprit de corps.

"The especial duties of the artillery district commander are to look after the equipment, artillery supplies and general fighting efficiency of all the forts in his district. The general discipline and fire discipline of the entire artillery district is kept up to a high standard by frequent inspection of the material to the smallest detail possible, and by frequent tests of the manning bodies of the several fire commands and forts in simulated action and actual target practice and fire control. The artillery district commander has charge of all matters relating to the completeness of the equipment and the efficiency of the personnel, and by these frequent inspections the actual work of the troops may be determined and compared. The effect of this has been to excite generous rivalry between the forts and to increase the smartness and drill efficiency along the whole line."

Every other advantage to the artillery as a whole which I have seen mentioned as obtained by our present system is, when examined, due to our now having a chief, not to the abandonment of the regimental system.

An advantage which effects only the field artillery is that we now have field artillery battalions, regularly and independently organized. This is evidently good ; but we could at any time, had we had a chief to urge the matter, have organized the field batteries of each regiment into a battalion and assigned a field officer of the regiment to command it.

So much for discussion—for criticism or commendation of either of the plans that we have tried. I conclude, from all the foregoing considerations, that a regimental system, if one can be devised that is fitted to the requirements noted, is at least as practicable as a corps. Taking them to be about on equal terms as to workability, let us, before trying to construct a regimental system, consider whether there is any general consideration which would lead us to prefer it.

To state the proposition is, I think, to answer it in the affirmative. For the old 6th and 7th regiments I cannot speak from personal knowledge ; possibly their regimental spirit had not fully developed. But certainly a regiment is the proper organization to develop esprit de corps ; small enough to be knowable, large enough to have friendly rivalry between batteries—that same rivalry spoken of in the extract quoted above from the JOURNAL, only in greater measure than I have ever seen it in a district. Our corps is too large, our company too small, for any such growth of spirit ; our districts are not sufficiently permanent as to personnel.

At least the first five old regiments had a regimental spirit, in spite of all the disadvantages under which the old regiments labored ; and a healthy regimental spirit gave us all an artillery spirit. In the regimental days, we have all seen, when artillery troops were serving alongside other arms, how the former, both officers and men, had a cohesion, a sort of unconscious pride in their regiment and arm, which we do not see now. Speaking for my own regiment, I think I can say that, while it has served side by side with many cavalry and infantry regiments, I never saw one of either that excelled it in that particular ; every one seemed to have a subconscious feeling that he was glad he was an artilleryman, and of that particular regiment. In our army we never raise regimental spirit as high as do some foreign armies, and don't expect to. But I think we of the artillery used to have our share of it, whatever it was.

And that spirit is a magnificent thing. When one feels that he belongs to the regiment; knows and is known by it; watches and is watched by it; feels that his battery is an integral part of it; feels that his battery is his own, and himself an integral part of the battery; knows that where the regiment goes the battery, ordinarily, will go; and that where the battery goes he also, ordinarily, will go;—when he gets all these ideas (and he will get them) so soaked into him that he is controlled by them without consciously thinking of them; then he is going to work with some enthusiasm for the little daily improvements in battery or regiment, since all such work is more or less for himself, and permanently so.

But with our corps, much of this spirit vanishes, and I do not see how it can be restored. We do our work,—I think we all at least try to do our duty,—but much of the enthusiasm is gone out of it. We don't feel as if we belonged to anything, and we are doing our duty more because it is a duty than before. Most officers with whom I have discussed it seem to have this feeling; many, at least, of the men have it—some, on occasion, say so, others simply act as if it were so.

If, then, we have two possible systems, equally workable, and one fosters esprit de corps, the other weakens it, why choose the latter?

And now let us see if we can devise a regimental system which will fulfil our requirements. The following scheme will, I think, stand the test in all essential points. It is submitted after much study, and much discussion with other officers; perhaps if the details require change the framework may stand. Or, better yet, perhaps someone else may be moved to give us a better plan.

I will merely remark, to begin with, that our present strength has been taken as a basis to work from.

PLAN FOR REORGANIZATION OF THE ARTILLERY.

1. The artillery corps shall consist of one chief of artillery, an unassigned list of officers and enlisted men, and sixteen regiments.

2. The chief shall have the rank of brigadier-general; his duties shall be, in general, such as are performed by the chief at present.

3. The unassigned list of officers shall consist of such officers as may be assigned to duty in the office of the chief; such as are detailed in the staff departments or as artillery inspectors; such as may be on duty without troops as instructors

or students at the schools at Forts Monroe, Totten and Riley, and such as may be detailed to duty at the U. S. M. A., or at military schools and colleges throughout the country. The detail of an officer to this list shall create a vacancy in his regiment; an officer relieved from such duty will be carried as supernumerary until a vacancy occurs for him.

The unassigned list of enlisted men shall consist of such men as may be detailed to duty at any of the above-mentioned artillery schools either as clerks, laborers, etc., or to take courses of instruction. Their accounts shall be kept by the adjutant of the school. Detail of a man to this list shall create a vacancy in his grade in his battery; when relieved, he shall join his battery and be carried as supernumerary until a vacancy occurs in his grade.

4. Each regiment shall consist of 1 colonel, 1 lieutenant-colonel, 2 majors, 3 captains as regimental staff, 3 first and 3 second lieutenants as battalion staff, 1 regimental sergeant-major. 1 regimental quartermaster-sergeant, 2 master electricians, 3 battalion sergeant-majors, 3 battalion quartermaster-sergeants, 6 electrician sergeants, two regimental clerks (sergeants), 6 battalion clerks (corporals), 1 band, 8 coast batteries and 2 light batteries. All details of officers to regimental or battalion staff shall be made in the manner now prescribed for other arms of the service.

5. Each coast battery shall consist of 1 captain, 1 first and 1 second lieutenant, 1 first sergeant, 1 quartermaster-sergeant, 1 battery clerk (corporal), 2 trumpeters, 2 artificers, 2 cooks, 8 sergeants, 12 corporals, 40 first-class privates and 40 second-class privates; provided, that the chief of artillery may at any time direct that the number of privates in any battery shall be reduced to not less than 25 of each class, or increased to not more than 60 of each class, such increase or reduction to be accompanied by a proportional change in the number of sergeants and corporals, and any battery whose authorized strength is over 125 enlisted men to have an additional cook; and, provided further, that, if at any time, the authorized strength of any coast battery shall be below 85, and that of any other battery of the same regiment shall at the same time be over 125, the chief or the regimental commander may detach one lieutenant from such smaller battery and assign him to such larger one.

6. Each field battery shall be organized as now prescribed, or as may be directed by the Secretary of War; provided, that privates shall be divided approximately equally into first and second

class, and that each battery shall have a clerk as provided for coast batteries.

7. Each regimental commander will, subject to the approval of the chief, assign a field officer to command the light batteries, which will ordinarily be equipped alike and stationed together; this detail will not be changed except for good reasons. The battalion staff and noncommissioned staff will be appointed from the regiment at large upon recommendation of the battalion commander; staff officers as provided above, noncommissioned staff subject to such examination as the chief may direct.

8. Officers of the regiment will be assigned to light batteries by the regimental commander, subject to the approval of the chief. Such details will ordinarily not be changed so long as the officer detailed remains in the same rank and in the regiment.

9. All the coast fortifications in the United States and insular possessions shall be divided into 16 regimental districts, which shall be designated by letters around the coast in rotation, down the Atlantic coast and up the Pacific. Porto Rico shall, for the present, be attached to a mainland district; other foreign possessions shall not be considered until they possess permanent fortifications The 16 regiments, in order, shall be assigned to districts, the coast batteries manning the fortifications and the light batteries being stationed as near as circumstances will permit.

10. Every five years the regiment in district A shall relieve that in B, and so on, all movements shall take place simultaneously, detachments being sent ahead to take over property, etc. If the exigencies of the service will not permit the changes to be made at the exact time prescribed, as near an approach as possible will be made to it.

When fortifications exist in foreign possessions, districts will be organized there; these may be included in the regular series if desired, or may form a separate group of foreign service districts, the regiments to be relieved every two and a half years by the regiments longest off foreign service.

11. The batteries of a regiment entering upon duty in any district shall be assigned to posts and to fortifications by the regimental commander, subject to the approval of the chief. The chief shall determine the number and strength of batteries to be assigned to any particular fortification, and batteries so assigned shall be recruited up or allowed to run down as may be necessary. No attempt will be made to divide batteries among

posts on battalion lines, and no permanent coast battalions shall be organized.

12. If the district consist of more than one post, the most important one shall be commanded by the regimental commander and the next two by the two remaining field officers, to each of whom shall ordinarily be assigned a battalion staff, selected as above prescribed for the staff of the field battalion.

13. Regimental commanders shall make such inspections and perform such other duties within their districts as are now prescribed for district commanders, subject to the regulation of the chief. In districts where the chief deems it proper, he may divide the districts into two or more subdistricts, giving the field officer in command of such subdistricts supervision over all the posts therein, subject, however, to the authority of the regimental commander.

14. If it should prove inadvisable to divide certain defenses precisely on regimental lines, and hence if part of any regiment be assigned to serve under a regimental commander not its own, such part shall be for the time, for tactical purposes, under the command of such other regimental commander in the same way as, for example, a squadron of cavalry at an infantry regimental post.

15. The pay of all grades shall be generally the same as in the engineers, with such modifications as may be found necessary or appropriate. Special pay for gunners and master gunners shall be allowed.

16. Bands shall be organized as at present. The Secretary of War may, in his discretion, organize one mounted band, to be designated as the "Light Artillery Band". Its habitual station shall be Fort Riley, but it may be temporarily attached to any other station or body of troops. Its members shall be supernumerary to the artillery establishment.

17. In organizing the new regiments, companies 1 to 8 and batteries 1 and 2 shall constitute the 1st Artillery; companies 13 to 20 and batteries 3 and 4, the 2nd; companies 25 to 32 and batteries 5 and 6, the 3rd; and so on, in each case beginning each new regiment with what was formerly Battery "A" of the corresponding old one. After seven new regiments have been organized, the remaining companies and batteries shall be grouped into regiments in the most convenient manner, and the necessary additional batteries organized (2 coast and 2 field).

SUMMARY OF STRENGTH.

Officers:—Brigadier-general, one.

Each regiment, 1 colonel, 1 lieutenant colonel, 2 majors, 13 captains, 15 first lieutenants, 13 second lieutenants; total, 16 colonels, 16 lieutenant-colonels, 32 majors, 208 captains, 240 first lieutenants and 208 second lieutenants. To this establishment will be added such supernumerary officers as may at any time be upon the unassigned list.

Enlisted Men.—The strength will vary, according to necessities; average about 20,000.

Remarks.—Coast and field batteries have been kept together in the same corps, since a large number of officers (of whom I am one) believe our present policy in that matter the wisest one. This, however, is a point upon which all do not agree; if it should be desired to separate them, that need not affect the organization suggested for the coast batteries.

The name "battery" is used instead of company for the reason that I think most officers have an attachment for the old term. The confusion between men and guns is theoretical rather than real; I, at least, never knew of any misapprehension arising from the double use of the word.

It may be thought that it will be difficult to divide our fortifications into districts of anywhere near the same size without entirely disregarding natural lines of separation. It will be found in practice that this is not so, if the variable strength of the battery be kept in mind. Thus, four mortar pits can be manned equally well by two large batteries with four officers each, or by four smaller ones with two officers each; rapid fire guns may easily be grouped in different ways; submarine mine work may be handled on the same principles as the mortar pits, or done by special details, as at present, etc.

For example, I give below a possible scheme for arranging regimental districts. With very few exceptions the garrisons suggested have the same number of batteries as those now at the posts. If a larger force were used, the garrisons could, in many cases, be made more adequate, and some districts more compact; but even with the strength given above, the regimental districting compares very favorably with the present arrangement. For purposes of comparison, the strength now at all posts is given, in a separate table.

REGIMENTAL DISTRICTS.

(Figures in parenthesis indicate number of batteries. Where none is given, post is ungarrisoned, or manned by detachments only.

District A.—Preble (2), McKinley (2), Levett (1), Constitution (1), Williams (2), Scammel, Foster.

District B.—Banks (2), Warren (2), Strong (2) Revere (1), Andrews (1), Heath, Standish, Independence.

District C.—Adams (4), Greble (2), Wetherill (1), Rodman (1).

District D.—Wright (2), Trumbull (2), Terry (2), Mansfield (1), Michie (1).

District E.—Schuyler (2), Slocum (1), Totten (5).

District F.—Hamilton (4), Wadsworth (4).

District G.—Hancock (4), Dupont (2), Mott (1), Delaware (1).

District H.—Monroe (8).

District I.—McHenry (3), Howard (2), Carroll (1), Porto Rico (2), Smallwood, Armistead.

District K.—Washington (4), Hunt (1), Caswell (3).

District L.—Moultrie (3), Sumter (1), Screven (3), Fremont (1).

District M.—Key West Barracks (3), Dade (1), DeSoto (1), Taylor (1); subdistrict, under a field officer, Jackson Barracks (2), St. Philip, Jackson. Garrison to be relieved by other troops from same regiment every two and a half years.

District N.—Barrancas (5), Morgan (2), McRee (1), Pickens, Gaines.

District O.—Miley (2), McDowell (1), Baker (3), Alcatraz. Subdistrict, under a field officer, San Diego Barracks and Fort Rosecrans (2).

District P.—Presidio (7), Scott, Mason, Stevens (1).

See note on Columbia River below. All San Francisco defenses should, for tactical purposes, conititute one command under the senior of the two colonels.

District Q.—Flagler (3), Casey (2), Worden (2), Stevens (1). See note on Columbia River below.

Columbia River Subdistrict.—Stevens (2), Columbia, Canby. Garrison: One battery each from Districts P and Q changed every two and a half years; commanded by field officer, furnished by the two regiments alternately.

PRESENT DISTRICTS.

Portland.—Preble (2), Williams (2), McKinley (2), Levett, Scammel.

Boston.—Banks (2), Warren (2), Strong (2), Revere (1), Constitution (1), Heath, Andrews, Standish, Independence, Foster.

Narragansett.—Adams (4), Greble (2), Rodman (1), Wetherill.

New London.—Wright (2), Terry (2), Trumbull (2), Mansfield (1), Michie.

Eastern New York.—Schuyler (2), Slocum (1), Totten (5).

Southern New York.—Hamilton (4), Wadsworth (4), Hancock (4).

Delaware.—Dupont (2), Mott (1), Delaware.

Chesapeake.—Monroe 8.

Baltimore.—McHenry (3), Howard (2), Carroll, Smallwood, Armistead.

Potomac.—Washington (4), Hunt (1).

Charleston.—Moultrie (3), Caswell (3), Sumter.

Savannah.—Screven (3), Fremont (1).

Key West.—Key West Barracks (3), Dade (1), DeSoto (1), Taylor.

Pensacola.—Barrancas (5), Morgan (2), McRee, Pickens, Gaines.

New Orleans.—Jackson Barracks (2), St. Philip, Jackson.

San Diego.—Rosecrans (2), San Diego Barracks.

San Francisco.—Presidio (7), Miley (2), McDowell (1), Baker (3), Scott, Mason, Alcatraz.

Puget Sound.—Flagler (3), Casey (2), Worden (2).

Columbia.—Stevens (2), Columbia (1), Canby.

San Juan.—El Morro and San Cristobal, Porto Rico (2).

Honolulu.—Camp McKinley (no fortifications) (2).

Manila.—(No fortifications) (4).

Temporary Station.—World's Fair, St. Louis (1).

A question might arise whether business might not be unduly delayed in case batteries of a regiment were detached and sent to a distance, say to the Philippines. This would rarely happen except in case of field batteries, but might in case of coast batteries, occasionally. Delays in the States would be slight, usually less than is now the case with other arms; for foreign service, the batteries might be noted on the regimental return as on such service, and dropped; the commander of the battalion or other detachment would then make his returns direct, and should be authorized to appoint noncommissioned officers. The same plan might, if desired, be followed when foreign service districts have to be established, to meet the possible case of a regiment garrisoning several small stations some distance apart.

And now, in conclusion, let us say that nothing is farther from my mind than to depreciate the progress the artillery is making. But in seeking improvement in material and methods, we must not forget that we have primarily to deal with men; and that these men, whether commissioned or enlisted, will not be good artillerymen until they are first good soldiers. If it were my own opinion only I could not venture to put it forward, especially as I find some who emphatically disagree with me ; but I find a very considerable number of officers, in all parts of the country, who agree with me in thinking that an organization on some such lines as sketched above would be better adapted to produce soldiers, and so lay the foundation for artillerists, than our present one ; and that for finishing the work and developing the soldier into the artillerist, it would be equally good.

No one officer can, however, get an idea by his individual efforts of what the mass of the corps thinks ; so the whole object of this article is to attempt to stimulate discussion which may show, sooner or later, what the real wishes of the corps are.

PROPOSED COEFFICIENTS OF HUMIDITY.[*]

For Use With Ingall's Table of Factors, $\frac{\delta_1}{\delta}$.

By J. J. O'REILLY, Frankford Arsenal.

In doing ballistic work, when the observed relative humidity differed materially from the "two-thirds saturated" basis of the above named table, it appeared to the writer that, for reasons similar to those governing the use of factors for mean altitude of the trajectory, it might be well to consider observed variations in relative humidity, if coefficients were available to modify the factors for observed pressure and temperature taken from the table, according to the observed variations from its basis of 67% relative humidity.

Analysis of the table showed that it practically satisfies the following assumptions:—

With relative humidity 67%, the ratio $\frac{\delta_1}{\delta}$ is taken as unity, for barometer 30″ and thermometer 60°.

For other barometer readings, at 60°, density varying directly as the pressure, the ratio is respectively increased or reduced by the product of the reciprocal of the reading and its number of inches below or above 30″, viz:—

For 28″, the ratio is $1.000 + 2 \times .0357 = 1.071$.
For 29″, the ratio is $1.000 + .034 = 1.034$.
For 31″, the ratio is $1.000 - .032 = 0.968$.

For other temperatures, density varying inversely as the volume, the ratio is respectively increased or reduced by the coefficient of expansion of gases for each degree above or below 60°, viz:—

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[*] (Extract from pages 8 and 9 of Weather Bureau Circular No. 235.)

Faulty Conceptions.—A false notion that the *air* has a certain capacity for moisture is widely prevalent, and is perpetuated by all such expressions as "The air is partly saturated with moisture," "Weight of aqueous vapor in a cubic foot of *saturated air*," etc.

It should always be clearly observed that the presence of the moisture in any given space is independent of the presence or absence of air in the same space except that the air retards the diffusion of the vapor particles. It is more correct to say, in the above cases, that the *space* is partly saturated with moisture, or that the moisture is in a partly saturated condition or is superheated. By all means use the phrase "Weight of a cubic foot of saturated aqueous vapor," not "Weight of aqueous vapor in a cubic foot of saturated air."

For 59°, the ratio is 1.000 — .002 = 0.998.

For 61°, the ratio is 1.000 + .002 = 1.002, and so on.

Under these assumptions the table gives the ratios of the density of air and water vapor two-thirds saturated, at barometer 30″ and thermometer 60°, to that at the same, and other, pressures and temperatures, the former ratio, 1.000, being the basis of the table.

The density of water vapor being about five-eighths that of air, more or less of the former would respectively reduce or increase the density of water vapor and air; and therefore corrections for humidity, above or below 67%, would respectively increase or reduce the ratios of Ingall's table. For such corrections a factor or coefficient of relative humidity, in terms of percentage, is required.

The saturated water vapor pressures, in inches of barometer, for each degree of temperature, given in Weather Bureau Circular No. 235, (which see, pages 8 to 12 for fuller explanation), afford data for obtaining coefficients of humidity.

The vapor pressure V being a part of the barometric pressure B, the ratio of the former to the latter, $\frac{V}{B}$, is a coefficient of relative humidity at saturation S, in terms of pressure. The ratio of the coefficient of relative humidity at saturation, S, to the percentage of humidity at saturation P, i.e., $\frac{S}{P}$, is a coefficient of humidity H, in terms of percentage of relative humidity, for each one per cent of the latter.

Forming equations of the above terms:—

$S = \frac{V}{B}$ and $H = \frac{S}{P}$, therefore $\frac{V}{B} = HP$, and $H = \frac{V}{BP}$ in which $P = 100$ is a constant, and $B = 30$ may be taken as a constant, it being the mean of the usual range of barometric pressure.

Substituting the product of these constants in the last equation, it becomes $H = \frac{V}{3000}$.

From this equation a limited number of results have been obtained, and embodied in the following table.

The coefficient for 60°, .00017, (Table I) derived from pressure, has been confirmed by coefficients derived from the effect of combining saturated water vapor and air, on the density and volume of the two, their mean being $\frac{(.00016 + .00018)}{2} = .00017$, and also by interpolation of Ingalls' table for factors, at 60° and

and 30″, modified by the proper proportion of the saturation vapor pressure at 60°, .517, viz.:—

For 100% humidity, 1.000 + .172 × .034 = 1.006.
For 0% humidity, 1.000 — .345 × .032 = 0.989.
Difference between modified factors, 0.017.
Coefficient for 1% humidity at 60°, 0.00017.

Table I.

Temperature, degrees	Saturation vapor pressure, inch.	Coefficient of relative humidity for each one per cent.
10	.063	.00002
20	.103	.00003
30	.164	.00005
40	.247	.00008
50	.360	.00012
60	.517	.00017
70	.732	.00024
80	1.022	.00034
90	1.408	.00047
100	1.916	.00064

Before applying any coefficient of humidity, the proper factor for observed temperature and pressure is to be taken from Ingalls' table, then calling any observed relative humidity X%, the tabular factor is corrected as follows:—

For X above 67%, add to the factor, (X —67) times the coefficient.

For X below 67%, take from the factor, (67 — X) times the coefficient.

For example, let the observed relative humidity be 90%, temperature 80°, barometer 29.5″, then the tabular factor is 1.057 and the coefficient is .00034; therefore:—

1.057 + [90 — 67) .00034 = 1.065.

Again let the observed relative humidity be 40%, temperature 20°, barometer 30.5″; then the tabular factor is 0.906 and the coefficient is .00003; therefore:

0.906 — (67 — 40) .00003 = 0.905.

It therefor appears that the ratios of Ingalls' table can be modified for any observed relative humidity, and that the greater change occurs when under usual conditions, the relative humidity exceeds the 67% basis of the table.

It is known that, density varying directly as weight of unit volume, ratios derived from weights given in table IV, corresponding to relative humidities given in table I, of Artillery Circular D, have been used in place of Ingalls' ratios, when relative humidity was more or less than 67%, but the former differ from the latter under like conditions. Ingalls' table has the merit of being exact for any definite value of the density of the atmosphere under the condition of 66⅔ % relative humidity.

NOTE.—Comparison of ratios named in last paragraph above.

BAROMETER 30″.

Artillery Circular D, Tables I and IV.

$$\text{Table I}\ \begin{cases}\text{Relative humidity} = 68\% \text{ at } 60^\circ \text{ column } 6.\\ \text{"} \qquad \text{"} \quad = 68\% \text{ at } 90^\circ \quad \text{"} \quad 9.\end{cases}$$

$$\text{Table IV}\ \begin{cases}\text{Column } 6.\\ \text{"} \quad 9.\end{cases} \frac{W}{W} = \frac{W\,(60^\circ, 68\%)}{W\,(90^\circ, 68\%)} = \frac{529.7}{496.8} = 1.066.$$

INGALLS' TABLE.

$$\frac{\delta_1\ (60^\circ, 67)}{\delta\ (90^\circ, 67)} = 1.059.$$

Difference (neglecting difference 1 + per cent. relative humidity) 0.007.

ARTILLERY IN BATTLE YESTERDAY AND TO-DAY.

By E. THIONVILLE, Major of Artillery.

Translated by Captain John E. McMahon, Artillery Corps.*

Since the adoption of the rapid-fire field gun, the tactics of the artillery have been oriented anew. While the old regulations laid down that the first duty of the artillery was to seek out the enemy's guns and endeavor to secure as quickly as possible superiority of fire, our present book tells us that, in the preparatory engagement, that is to say, in the beginning of the battle, we should facilitate the advance of the infantry, support its partial attacks, that *we shall in this manner be led into a series of successive struggles with the enemy's artillery.*

It is a fair question to ask why we have been thus led to turn our attention from the enemy's guns and concentrate it on his infantry. The nearer the field gun is brought to perfection the more does infantry suffer from its fire. It would seem then at first sight, that the improvement in material, instead of causing the disappearance of the artillery duel, would make it still more necessary. On the other hand, in the past as at present, the infantry had need of us in its advance, and the close union of the two arms was laid down in the old regulations as a fundamental principle. Why is it, then, that our present book seems to establish a new axiom, and that what was necessary yesterday becomes still more so to-day?

In the past, as in the present, artillery has but one object—to support the infantry. The infantry bears the brunt of the battle, the artillery is there only to help it to accomplish its task; to arrive at this result it must engage the enemy's artillery and infantry. Of these two objectives it is naturally led to select the one upon which it has the greatest effect; and the entire change in its tactics results from the fact that it is at present infinitely better prepared than formerly to act against infantry, while its effect upon artillery has become very much more uncertain.

With the old methods of fire—the narrow fork and fire for effect on a single elevation—artillery was effective against a continuous line of skirmishers or reserves in masses, but it was practically powerless against the many small columns scattered along a wide front, the actual formation adopted by the infantry in its advance. To reach these columns it would have been necessary to divide the battery, to assign, so to speak, a definite target to each gun—a method to which we were not accustomed, and which, moreover, would have produced no definite results.

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* Revue d' Artillerie, January, 1904.

With the rapid-fire field gun, on the contrary, we can cover uniformly, and, in a very short time, a wide and deep zone, and we can thus prevent the movement of troops in this zone, no matter what their formation may be. It is true that there was no reason why this method of fire should not have been adopted for 90 mm. gun ; but think how much time it would have taken for a battery to accomplish the same results, and how many batteries would have been needed to produce these results in the same time.

The maximum rate of fire of a battery equipped with the 90 mm. gun was twelve shots a minute, or two shots per gun ; it would then have required four minutes for each gun to deliver the eight shots prescribed in zone fire. To fire thirty-two rounds in thirty seconds, as is done in zone fire* with the rapid-fire gun, would require sixteen 90 mm. guns, supposing each to have been loaded and ready at the moment of fire, and also that the four elevations employed in zone fire should be divided among the sixteen pieces—which evidently would have been practically impossible.

We can safely say, then, that at least three 90 mm. batteries would have been necessary to produce the same effect against infantry as one 75 mm. battery ; and it is evident, therefore, what a considerable quantity of artillery would have been necessary to support the infantry in its partial attacks as efficiently as is done to-day. There would not have been enough batteries in an army corps, nor enough ground on which to use them. This is why in the past we left the infantry to enter upon the preliminary engagement almost by itself, and we held off until the decisive attack, when the front became less extended, the objectives more vulnerable, and, as a consequence, the effect of our fire was greatly increased.

During the first part of the battle we had but one object ; to seek out the enemy's artillery, engage it and obtain against it a superiority of fire. Let us consider under what conditions we now enter upon this contest.

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* Tir progressif, sans fauchage, or zone fire without sweeping, consists of 32 rounds per battery, or 8 rounds per gun, at four ranges, varying by 100 yards ; in zone fire with sweeping, each gun fires 3 shots at each range, or a total of 48 rounds per battery.—TRANSLATOR.

The pointing apparatus used with the old material made it very difficult to use indirect fire, which was only exceptionally employed ; direct fire was the rule, and, as a consequence, the artillery was always more or less visible. No doubt this visibility had been greatly lessened by the adoption of smokeless powder ; but as a matter of fact a battery when firing could never completely conceal itself, and always furnished a target easy to find. As soon as a hostile battery appeared it became a target ; and, as we could not hope to obtain superiority of fire except by employing a greater number of guns than the adversary, we hastened to call up another battery to add its fire to that of the first. The enemy naturally did the same, and so we came to the long lines of artillery, to the use of artillery in mass, in order to begin the artillery duel.

This duel once begun was fought to a finish ; and the finish generally came when one side was made to realize its inferiority and partially to suspend its fire. The batteries equipped with the old material, being without any method of sheltering the cannoneers, had to continue their fire when once engaged ; and when they could fire no longer, it was a fair conclusion that the guns had been dismounted, or the chests had become empty, and that in consequence they were out of action for a certain time.

Thus the artillery duel went on, furnishing for a long time a particular phase considered indispensable in every battle. To it was ascribed all sorts of tactical qualities—it made easy the deployment of the other arms, gave to the commanding general time to make his dispositions, etc.—things undeniably true, but which are only the consequences of this basic truth ; the artillery duel was forced upon us artillerymen because it was the only means of effectively employing our material in the first part of the engagement.

Let us consider what conditions we should have to meet to-day if we were to pursue the above methods, supposing, of course, that our adversary is equipped with a material similar to ours. Since in the new equipment we are independent of the line of sight and hence can always use indirect fire, a battery of 75 mm. guns, if skillfully handled, will be completely masked, and so it will be very difficult to locate the enemy's artillery. This artillery reveals its presence when it begins to fire ; what are we going to oppose to it? In general, an equal number of batteries ;

remembering, however, that a battery can now cover a front greater than its own, and hence only the *least possible number of batteries* should be engaged, and not the greatest possible number, as formerly. As a consequence of this, a great part of the artillery will be for a time unused. Since the fire will be necessarily intermittent, we can not conclude that a battery has been put out of action because it is silent ; it has ceased to fire only temporarily, because it wishes to do so, and it can re-enter the action at any moment. Having with more or less difficulty obtained the range of the battery thus concealed, we begin our zone fire ; the hostile battery remains silent. Are we to increase to infinity the intensity of our zone fire, in the hope of destroying it ? Evidently not. The personnel is safe behind the shields, and has not much to fear from our rafales ;* we would be emptying our chests without producing any great result. Consequently, we follow their example ; we remain silent, ready to resume the fire if they begin again. Thus it appears how difficult it is to mark the end of the artillery duel, and in what an uncertain state we find ourselves as to results produced. This is true, of course, only when the enemy's batteries make the fullest use of the advantages peculiar to their material and remain completely concealed ; for if one of them becomes visible, we encounter the same conditions as prevailed in the past. We proceed at once to deliver against this imprudent battery zone-fire, fire with a single elevation, or fire against the material ; in other words, we concentrate our fire upon it, not, as formerly, by directing the fire of several batteries against it, but rather by the *repetition of the fire of a single battery*. In every case the result is the same ; for this battery the artillery duel is over, we have put it out of action. But this will be only the exceptional case ; and if during the preliminary engagement several batteries allow themselves to be surprised, the others will quickly take advantage of the experience gained and will conceal themselves completely from view.

It is plain, then, that we cannot consider the artillery duel under the same aspect as formerly, that we can no longer invite the enemy's batteries to this strange combat, to this preliminary struggle, from which one or the other came forth completely victorious,

To-day the opposing batteries will feel around for each other, will deliver attacks short and violent, but never decisive. The more skillful of the two will soon succeed in paralyzing its adversary for the time being by keeping it under the menace of its rafales; but to do this it must watch the other unceasingly, and consequently cannot take advantage of its superiority by devoting itself to other work.

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* Rafale, literally squall, is the name given by the French to the storm of projectiles thrown from their rapid-fire gun in a particular kind of fire. There seems to be no word in English to give its exact meaning.
—TRANSLATOR.

We thus get at a much more sensible idea of the artillery struggle. It is no longer a distinct and particular phase of the battle consecrated to the artillery alone; it is an episode, a consequence of the infantry combat which we must follow step by step from the preliminaries of the struggle up-to the final act.

And as a matter of fact, since the hostile artillery is sheltered in a measure from our view and our projectiles, is it not natural for us to concentrate all our attention on the infantry, which cannot escape us and against which we are powerfully armed? Undoubtedly this infantry will also conceal itself, will take refuge behind cover, will shelter itself behind obstacles; but there will always be a moment when it will have to show itself, that is, when it wishes to fire. Our own infantry will enable us to take advantage of this moment; its advance will force the enemy to show itself and then it is that we will strike hard quickly, for it is only at this moment that we can count on producing any effect. It is thus easy to understand the necessity of watching unceasingly our own infantry, of not losing sight of it for a single instant, of going forward hand in hand with it. This co-operation of the two arms on the field of battle, this intimate union of the artillery and infantry, recognized from all time as a tactical necessity, becomes for us artillerymen a technical necessity, so to speak; for it is the infantry that makes our target appear, and that allows us to take advantage of the marvelous qualities of our gun.

But the enemy's artillery will not remain inactive; it will do exactly as we have done, and open fire either upon our own infantry or upon the batteries that are accompanying it. It is then that we shall engage it, and endeavor, if not to destroy it, at least to neutralize it and keep it quiet under our rafales.

The artillery, then, has two rôles to fulfil—to fight the hostile artillery and support our own infantry. And these two rôles, which are no longer successive as before, but simultaneous, cannot be filled by the same batteries and so arises the necessity of dividing the artillery into two groups—one to hold in check the enemy's batteries, the other to accompany the infantry.

All that we have said above in regard to the use of the rapid-fire field gun is to-day universally acknowledged, and is no longer a subject for serious discussion. This cannot be said to be true concerning the question which we now proceed to discuss.

What is meant by this division of the artillery into two groups, and this rôle of accompanying the infantry?

The name of "crest-artillery" is often given to the batteries whose duty it is to engage the enemy's guns, while those detailed to accompany the troops are called "infantry-artillery."* Taking literally this theoretical distinction, some officers seem to think that the technical use of the arm will be confined to the crest-artillery alone, which remains massed under the control of its chief, while the rest of the artillery will be split up into completely independent fractions, without any tactical cohesion, and scattered among the different fighting units of the infantry, so as to fill the rôle of machine-guns or separate pieces attached to battalions. This artillery, divided into small groups of platoons, or even of single pieces, it is claimed will easily find protected routes of approach, and can thus follow the infantry step by step in its forward movement, giving it the moral and material support so much needed.

If this moral and material support for the foot soldier consists in seeing the gunners march alongside them, it is certain that this method of employing artillery will furnish it; but if, on the contrary, it consists in constant intervention by sudden and timely rafales, we fear very much that this manner of using the guns will not give the desired support.

How are we to admit that these little groups, constantly moving, will be able always to find emplacements from which they can *see* what is happening on the skirmish line? And even supposing that they do find such places, is it probable that their chiefs, who often will be officers of the reserve and even non-commissioned officers, will be sufficiently familiar with the necessities of the battle to intervene at the proper moment?

In his last study on "The Lessons of Two Recent Wars," † General Langlois enumerates the duties of the artillery in the preliminary engagements.

The artillery should intervene:

1st.—When the firing line halts to fire. It is the enemy's fire that makes the line halt; the artillery must then, by its rafales, force the enemy's skirmishers to lie down and cease firing, thus allowing our own infantry to resume the advance.

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* On this subject see "Tactical Consequences of Progress in Armament," by General Langlois. Paris. 1903.

† The Lessons of Two Recent Wars, p. 83. Paris. Lavauzelle.

2nd.—When our skirmishers halt to entrench themselves. During the pause the enemy must be prevented from firing.

3rd.—When the echelons, coming from the rear, join the skirmish line to carry it forward. This movement must be facilitated by a slackening of the enemy's fire.

4th.—When the enemy's reserves advance to the first line to reinforce it. This movement is generally made in the open, for the first line, in order to see, must come out in front of the crest. The artillery should stop this forward movement of the reserves and prevent them reaching the first line.

Now in order to take advantage of these different phases of the battle and be able to intervene in an effective way, should the artillery be on the heels of the skirmishers, or rather behind on a position dominating the field, from which it can see the entire scene of the struggle? Must we use platoons or isolated pieces, or rather batteries held well in hand by their chief? And finally, is it possible for the battery commanders to look after their men and their firing and at the same time give their attention to a surveillance of the battlefield?

There is no doubt about the answer. This rôle can be filled only by batteries so placed as to cover completely the ground over which the attack takes place, and by group commanders watching attentively the progress of the battle, and indicating to their captains the proper moment to intervene and the time when this intervention should cease.

This leads us to consider from an altogether different point of view the separation of the artillery into crest-artillery and infantry-artillery. Instead of assigning to one or more groups the duties of the crest-artillery, which, no matter how well placed, can with difficulty silence all the batteries which expose themselves along the front, and scattering the rest of the available guns among the different fighting units of the infantry, thus destroying all the links between the commander and his subordinates and all connection with the ammunition trains, we believe that this division should be made in the group * itself, whose chief can thus by applying the principle of the economy of forces, utilize in the way most suitable to the circumstances all the elements at his disposal.

Let us take, for example, the two groups of the divisional artillery. As the division has generally two regiments in the first line, we can assign one group to each regiment.

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* The group, in the French artillery, consists of three batteries. Two groups constitute the divisional artillery.—TRANSLATOR.

The divisional artillery commander indicates to the group commanders the mission and the objectives of each infantry regiment, and thus clearly limits the ground over which each group is to act. The fighting front of a regiment does not generally exceed 800 or 900 yards, so that in the majority of cases each group can find a suitable position allowing it to watch every portion of the front.

According to circumstances, the group commander will assign one or two batteries to the infantry combat, reserving to the other one or two the duty of countering. * Whenever the ground permits, he will mass his batteries as much as possible, being careful to keep them concealed, so that he may communicate with them easily, and by simple variation in the deflection meet the numerous changes of objective which occur in the progress of the battle and which we have enumerated above. It is here, more than anywhere else, that he has the opportunity of utilizing that striking characteristic of our new material, which consists in the possibility of securing, by the announcement of a single number, the transmission of his ideas. Instead of using individual pointing on this occasion, as we are tempted to believe would be done, we shall more than ever have recourse to collective aiming. †

The intervention of the artillery at this stage of the infantry struggle should be sudden and of short duration. How can he better secure this than by the command: "(To the right or left) increase or diminish by so many thousandths," ‡ instead of having recourse to the conversations and blind groping to which the designation of an objective usually gives rise? The group commander can thus deliver, anywhere along the front, the sheaves of fire from his batteries, supporting the different battalions in succession, and intervene at the proper time with the countering battery, if the enemy's artillery exposes itself along the front assigned to his group.

The batteries assigned to accompany the infantry have a rôle so important, that they must be prevented at all hazards from

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* The French term contre-battre, is difficult to translate accurately in a few words. It is used here in the sense of returning a blow, and is applied to the functions of those batteries who are to return the fire of the enemy's guns.—TRANSLATOR.

† In individual pointing each gun is aimed directly at the portion of the objective assigned to it, aud with the same deviation. In collective pointing, all the guns are directed on a common aiming point with different deviations, so that the whole front of the objective will be covered by the fire. —TRANSLATOR.

‡ The French deviation scale is a circular plate, graduated in thousandths of the range.—TRANSLATOR.

having their action impeded by the rafales of the enemy's guns. This can be done only by having behind them, under the control of the same chief, a countering battery ready to interpose. A distant line of crest-artillery having no tactical connection with them, evidently could not extricate them as quickly or as surely as a battery of the same group, which never loses sight of them and has no other mission than to watch over and protect them from threatened attack.

This seems to us to be the proper method of employment of the divisional artillery in the preliminary engagement. It secures the most effective possible support of the partial attack that the infantry have to make during this phase of the battle, while limiting these attacks to those delivered by a regiment, the smallest unit to which may be assigned an exact and complete rôle in the battle.

The regimental commander indicates to the group commander his intentions and the rôle of each of his battalions, and it then becomes the duty of the latter officer to support these battalions by making the best use of the elements at his disposal and by going to the assistance of each one of them whenever needed. If the artillery had been distributed from the first among the battalions, even admitting that these fractions of artillery were all well placed and well commanded, it might easily happen that the support rendered would be superfluous at one point and insufficient at another, without any means at hand of reinforcing one another. Here, as everywhere, the principle of economy of forces must prevail ; and to economize forces, it is necessary not to scatter them, but to keep them massed under the same hand.

If this is the rôle of the divisional artillery, it may be asked what becomes of the corps artillery. We are often tempted to believe that the functions of the crest-artillery will be reserved for the corps artillery, and that the era of long lines of guns and of action in mass will, in consequence, appear again. Undoubtedly in order to be able to entrust to the divisional artillery the task of accompanying the infantry, it would be convenient to admit that the corps artillery is to assume the rôle of keeping in check the enemy's artillery. But to admit this is to admit that the old artillery duel is still possible, and that the enemy will allow himself to be hypnotized by this deployment of artillery and will hasten to oppose it with all his available batteries. As we have pointed out before, it will not do to count upon this.

The great advantage of our present artillery is in being able to cover a front larger than the one it occupies. If the enemy knows how to utilize his batteries, he will engage our corps artillery with only the number necessary to keep them busy, keeping the others for use at other points on the battle field.

In general, the principal duty of the corps artillery will be to reinforce or relieve the exhausted divisional artillery, and in consequence it will follow, in the conduct of the battle, exactly the same principles.

It may be asked, why not distribute all this artillery amongst the divisions, or in other words why not do away with the corps artillery? This solution, adopted by the Germans several years ago, does not appeal to us. Outside of the consideration that it might be inconvenient to burden the division by attaching so much artillery to it permanently it might easily happen that a division would not have enough guns at a given moment, while at another it might have too many. We would then be compelled to take from one division a part of its artillery in order to supply its neighbor, a measure which would not be very practicable ; while it is always easy to borrow from the corps artillery and to obtain the same results thereby.

To sum up, we must not take too literally this division into crest-artillery and infantry-artillery ; and we must be especially careful not to look on them as of different natures, having distinct tendencies and methods of fighting. The whole of the arillery has but one object : To support the infantry from the beginning of the struggle to the final act, by attacking the enemy's infantry and artillery. This necessitates a distribution of the batteries,—a distribution varying at different points of the battle-field and at different periods of the fight, always regulated by the commanding officer of the artillery on the principle of the economy of forces. He must never lose sight of the fact that the infantry battle is the main object and the artillery combat is only a means thereto.

From this it results that every officer of artillery, of whatever grade, should become familiar with infantry, should study their tactics and modes of fighting, in order to understand, at every phase of the battle, just what they are doing and what they desire.

INFLUENCE OF THE ADOPTION OF THE NEW GUNS ON THE FIRE OF FIELD ARTILLERY.

TRANSLATED BY SERGEANT-MAJOR MAURICE H. ANTHONI, ARTILLERY CORPS.*

This is the title of a remarkable lecture recently given by Major Stappaerts. On account of the personality of the author, a high ranking officer of artillery and ex-professor of the War College, and in view of the interest of the subject and the way in which it is treated, an extensive analysis is made of it here for the benefit of our readers.

For some years in all the countries of Europe, the rearmament of field artillery has been the order of the day. In Germany since 1899 all the artillery of the active army is armed with the 7.7 cm. M. 1896 gun. In France since 1901 all the field batteries of the active army are armed with the 75 mm. M. 1897 rapid-fire gun. In Russia and Italy new models have been adopted, but their construction is not yet completed. In nearly all other countries, as in our own, tests are being made, and the adoption of a new gun is near.

The guns adopted in Germany, France and elsewhere are known, if not in all their details, at least in their main characteristics. We are also acquainted with the numerous models submitted to various governments by the large gun factories, Krupp, Schneider-Canet, Cockerill-Nordenfelt, Ehrhardt, St. Chamond, Skoda, etc. It is known that the characteristic quality of these guns is to allow of a greater rapidity of fire.

The lecturer does not discuss the advantages or disadvantages of one system or the other, and does not enter upon the question of whether rigid carriages or those with long recoil are to be preferred. He proposes only to examine and to see if the adoption of these new guns will make any great modification in the use of field artillery on the field of battle, and especially if it will change the methods of fire.

It has often been said, and with reason, that tactics must change with the effects of weapons. Each important modification in armament has been followed by a modification of tactics. But it is necessary that the modification be an important one ; that is, of a nature to modify sensibly the inherent power of one of the arms and especially its relative power with respect to that of the other arms. Is the adoption of the new guns of such a nature as to make a great modification in the power of fire of field artillery? Will the relation between the effectiveness of the fire of artillery and that of infantry be notably changed?

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* Revue de l'Armée Belge, November-December, 1903.

To answer these questions Major Stappaerts briefly reviewed the principal modifications made in fire arms during the last few years, and compared their importance to the last, that is to say, to the adoption of guns called rapid-fire guns. The most important change made in fire arms for a century, that which caused a radical modification in the employment of artillery and infantry fire, is the invention of rifled breech-loading arms. Let us succinctly recall the comparative status of fire arms before this development.

At the beginning of the 19th century, during the great wars of the Revolution and of the French Empire, we see the superiority of action of the smooth-bore cannon over the smooth-bore musket. The effective range of the infantry musket at that time hardly exceeded 165 yards, the rate of fire was very slow, it took the soldier more than a minute to reload his musket. At the same period, field guns, firing spherical balls, reached an effective range of 1095 yards (and even 1315 yards for those of the largest calibre, 12 cm.) Case-shot firing was effective up to 655 yards and wa,s accordingly, often the decisive fire in the attack. The proportion of case shot in the ammunition supply was a great deal larger than it is with rifled guns.

At that time fire action on the battle field pertained above all to the artillery. Napoleon attached little importance to infantry fire, the latter being for him mainly the arm for shock action. The foot soldiers of the "Vieille Garde" prided themselves upon bringing back intact their supply of cartridges after a campaign. In the defensive, the fire of infantry had a little more importance. It is also at that time that Souvarof said, "the bullet is foolish, the bayonet intelligent".

The method of artillery fire was very simple. Fire was by piece at a range judged by the eye, the sighting instruments were very rudimentary, sighting was more often done by the natural line of sight (line of metal of the gun), which gave the projectile a point-blank range of from 655 to 765 yards. The battery of 8 pieces was not a fire unit, but a tactical unit. There was no question of grouping the shots nor of ranging the pieces together, the lack of accuracy would have rendered ranging impossible. The battery commander had especially a tactical position; he indicated the target, superintended the fire discipline, watched over the security and mobility of the battery, the replenishment of ammunition, but he interfered but little with the fire. Each piece fired independently, and the result depended mostly upon the chiefs of piece and especially upon the gunners (the gunner was often the chief of piece). Aiming and laying was then the whole art of the cannoneer; the good gunner knew how his gun fired and corrected his fire, that is his aiming, from his own observations (as the range was short, the point of fall was more or less seen).

The method of firing a gun was then the same as with a musket. The gun was a large musket, the projectile of which was heavier, and consequently its range and accuracy greater, the effect at the target more considerable. To obtain from gun fire its full effect, it sufficed as with the musket to load the gun carefully and to aim it with precision. But the effect of the gun on the field of battle was considerable compared to that of the musket, and a great deal of importance was attached to the capture of the enemy's guns and to preventing the same from happening to one's own guns. The rapidity of fire of field artillery at that time was not inferior to that of ten years ago. With round shot, 1½ to 2 shots could be fired per minute; with case shot the pieces were not run forward after recoil, and 4 or 5 shots per minute could be fired, so that this rapidity was much superior to that of the musket.

The adoption of rifled arms, completed shortly afterward by that of loading by the breech, modified profoundly the conditions of efficacy of fire of the rifle and gun. The transformation begins with the rifle. The accuracy and range of the rifle increase as the methods of forcing and centering the ball are perfected. Also loading by the breech increases the rate of fire.

After the adoption of the Prussian needle gun in 1841, France adopted the chassepot in 1866; in Belgium the Albini was adopted in 1867, and soon all countries had a rifled musket of 11 mm. (or nearly that calibre), breech-loading and firing a bullet of 25 grams with a muzzle velocity of from 435 to 490 f.s. Not only does the rapidity of fire attain 8 to 10 shots a minute, but the ballistic power is increased ten-fold. The fire has a great effectiveness at 875 to 1095 yards, and even, in the war of 1870, certain volleys of the French infantry were seen to produce great effect at 1640 yards and up to 1970 yards.

If at that time the field artillery had not likewise been modified, not only would its superiority of fire have vanished, but it would have had to disappear from the battle field before the superiority of the rifled small arm. But guns were also rifled and made breech-loading (a little later than the musket). So that in the gun also the range and accuracy increase, and even in a larger proportion than in the rifle, because the calibre remaining unchanged, the weight of the projectile is increased by lengthening it, while in the rifle the calibre is reduced from 17 to 11 mm., the weight of the bullet remaining the same (25 grams).

Nevertheless, the relative conditions of both rifle and gun are much changed. The old case-shot fire so decisive up to 655 yards, can no longer be used except on rare occasions, for the artillery cannot come in battery with impunity at this distance from infantry whose fire is effective from 875 to 1095 yards. Thus the case shot almost disappears ; it is kept only as a projectile to be used, exceptionally, to defend the battery against an unexpected infantry attack at short range.

The fire with solid shot has but very little efficacy against living targets and notwithstanding the increase in range artillery fire would have become almost useless against troops if the solid shot had not been replaced by a hollow explosive projectile. Already in the first half of the 19th century spherical shrapnel had been introduced in field artillery, but besides the fact that the first fuzes (wooden ones) were defective, the range of this shrapnel did not exceed that of the shot (1095 to 1315 yards).

With the rifled guns came the explosive shell with percussion fuze. The invention of this percussion fuze had an enormous influence for field artillery. It is this that enabled the field gun to gain at long distances the superiority over the rifle, which it had lost at ranges below 1095 yards. First, thanks to this fuze, the effect of a single projectile on both obstacles and living targets increased considerably at all distances ; but the principal result of the use of this fuze, that which led to radical change in the employment of guns, was that it made possible the observation of the points of fall at all ranges and consequently the methodical regulation of fire based on this observation.

By study of the grouping of the points of fall, based on the calculus of probabilities, the great accuracy and range of rifled guns can be *practically utilized* and with observation of the points of fall determination at each shot can be made, from direct experience, of the elements of laying, which should make the mean trajectory reach the target. This is the important transformation in armament which has wrought such a great change in the employment of artillery on the field of battle and notably in the methods of fire.

The lecturer deals only with this last point. It is the introduction of firing methods based on the direct observation of shots which alone has been able to make artillery fire effective at long distances, by which the gun is superior to the small arm rifle.

It was soon recognized that notwithstanding the great ballistic power of the rifled musket of 11 mm. and its extreme range of 2185 yards, no reliance could be placed on the efficacy of its fire at long ranges (above 1000 yards). The few extraordinary results obtained during the war of 1870 and later during that of 1877-78, gave birth for a few years to great hopes in regard to the action of infantry volley firing at long distances, and many theories were developed on the employment of this fire, its application on varied ground, etc. ; it was even said that the rôle of artillery on the battle field was ended in view of the superiority of the rifle. But it was soon seen that this was all an illusion.

In rifle fire at long distances, the uncertainty of aiming plays too important a part ; besides it is utterly impossible to observe the points of fall and consequently to determine by direct experience the required elevation. Hence an elevation corresponding to the estimated or measured distance has to be used. The great errors made in estimating when the range is great are known ; no perfect instrument of practical value in time of war for measuring distances has been found. Besides, it is also known that an exact knowledge of the range does not give that of the elevation, the latter being dependent on many other conditions.

The rifled gun with its percussion fuze projectile allows the experimental determination of the elevation to be made at all ranges where the eye can see the target and the cloud of smoke produced by the explosion of the projectile. But to utilize this precious property of the gun the sighting instruments had to be perfected and also the method of determining the corrections for laying after the observation of shots.

In the war of 1866 the Prussians and Austrians employed their rifled guns very poorly in this respect. They fired very nearly the same as with smooth-bore guns, except that they had very much increased the distance at which firing was executed. Therefore their fire had little efficiency. But in 1870 Prussia had profited by experience. Immediately after the war of 1866 the Artillery Firing School was created, where the elaboration and teaching of the new rules of fire was begun.

The important rôle played by the Prussian field artillery in the war of 1870 and the great superiority of its fire over that of the French artillery is readily recalled. The latter had rifled muzzle-loading guns which could have perfectly well held their own against the German guns with respect to ballistic power, but which used a projectile with double time fuze, and they could not, in consequence, regulate their fire. The French still fired as with smooth-bore guns at the estimated range and counted on the depth of action of the time-fuze shells to carry to a distance the effect of case-shot fire; but this long distance firing without regulation of range could produce results only by chance.

After the war of 1870 all Europe adopted the breech-loading rifled gun firing an explosive shell with percussion fuze. Everywhere also, methods of fire based on observation of points of fall and study of groupings were applied. The adoption of these new firing methods led to a complete change in the manner of conducting the fire in the battery. No longer to the gunner alone is left the care of correcting the fire of his piece. From this time forward the battery commander is charged with applying the new rules; that is, it is he only who regulates the fire of his battery. He indicates to the gunners the point upon which they are to aim and, by the corrections he orders, he directs the concentration of the trajectories of his guns on the target he wants to hit. The battery has become the unit of fire, it is reduced nearly everywhere to 6 guns (instead of 8), forming a single collective instrument, directed by the battery commander, allowing him, by observation of the points of fall, to utilize practically and efficiently the accuracy and long range of the guns.

It is thus that after 1870 the tactics of artillery, as of the other arms, and the methods of fire were completely changed in consequence of the important modifications produced in the effects of fire arms, gun and rifle. Modifications made not only in the inherent power of each of these arms, but also in their relative power with respect to each other.

In the years following the wars of 1870, the field gun was still more modified, these improvements increasing the efficiency of its fire. In all countries, even those that had adopted the breech-loading rifle gun before 1870, as Germany and Belgium, the field material was completely renewed a few years after the war. The velocity was increased, thanks to hooping and progress realized in powder. The breech mechanism and means of obturation were improved, giving an increase of rapidity of fire which had diminished with the first rifled guns. A return is made to the rapidity of 2 shots per minute as in the time of the smooth-bore guns. The projectiles especially are perfected. However, fire with percussion shells, in spite of its accuracy at long ranges, remains inferior in its effects against troops to that old case-shot fire of the smooth-bores, which formerly up to 545 and 655 yards swept everything before it and promptly decided a battle at these short distances. It was by perfecting the time-fuze shrapnel that the crushing effect of the old case-shot fire was soon obtained at long distances (3280 yards). For this reason, therefore, shrapnel becomes the principal projectile of field artillery.

These various modifications made in field artillery material from 1870 to 1890 do not cause any important change in the mode of employment or in the manner of conducting the fire. Field artillery fire becomes more effective but the ranges change but little. The effective range of rifle fire does not change, so that the relative conditions ot the two weapons remain the same. The rifle retains its superiority below 1000 yards, the gun remains superior at long distances. This latter superiority is more accentuated by the increase of efficiency but has not brought about any change in the manner of firing. At the most, a tendency to simplify the rules of fire can be seen, the fire with time-fuze projectiles not needing to be regulated with the same precision as that with percussion projectiles. But observation of shots remains the fundamental rule for correcting the fire. Also greater precautions are taken to occupy artillery positions without being seen by the enemy. The great efficacy of artillery fire necessitated seeking cover, revealing one's presence only by the opening of fire. Much more attention was directed to indirect firing.

But towards 1890 a new transformation is made in the infantry rifle. For the 11 mm. rifle firing from 8 to 10 shots a minute, the magazine rifle of small calibre (7 to 8 mm.) firing from 20 to 40 shots a minute is substituted. At the same time this new rifle is superior to the old one in range, accuracy, flatness of trajectory, power of penetration and lastly it uses smokeless powder, which permits the infantryman to remain in a way invisible if he profits a little by cover of the ground.

Immediately, theories similar to those after 1870 made their re-appearance, the rapid-firing rifle with a bullet effective at 3,000 yards was to supplant the gun. Many artillerists were of the opinion that it was most necessary to apply to field guns the same improvements as had been made in the rifle. In fact, a few years back, small rapid-fire guns had made their appearance in the navy and fortress artillery. It was necessary that they be introduced in the field artillery as soon as possible in order to have more powerful and at the same time more mobile guns, able to fight against the rapid-firing rifle.

It was a prime error to believe that the superiority of field artillery fire was compromised by the adoption of the new rifle. The ballistic power of the latter has increased, that is the muzzle velocity, the range, the flatness of trajectory, are greater but this does not increase its efficacy of fire *at long ranges.* The extreme range reaches 4375 yards, but the rifle can not be fired usefully at this distance. It is well known that the sight is graduated to only 2200 yards as in the case of the chassepot of Albini (and even in the Albini the graduation was as much as 2295 yards).

Although the accuracy of fire (firing with a rest) is increased, the zones of longitudinal dispersion at long ranges (1640-1970 yds.) are greater in consequence of the lessening of the angles of fall. The increase in penetration is not perceptible at long ranges. In fact, it is only at ranges below 1000 yards that the effective power of infantry fire has increased, because of the greater flatness of trajectory and of the greater power of penetration. It is also at these short distances only that the rapidity of rifle fire can be utilized.

We have seen that since 1870 it is admitted that below 1000 yards infantry fire has the advantage over that of artillery. This advantage is to-day more accentuated, but that is all. At long ranges the artillery holds all its superiority. There is nothing changed, therefore, in the relative power of the two fire arms and it was not necessary to modify the gun to *counterbalance* the development of the rifle.

The tactical progress resulting from the adoption of smokeless powder could well be applied to the old guns (as it has been done) and it was not necessary to invent a new gun for this powder. The increase of efficacy of infantry fire at short distances makes the necessity of opening the attack with artillery more important but the conditions of this preparation have not changed neither do they necessitate a new gun.

But it is always advantageous to increase, if possible, the qualities of a fire-arm, and no reproach could have been attached to those who wanted to transform the field gun, if they had not erred a second time in wanting to apply to the gun the same methods of improvement seen in the rifle. They lost sight of the profound difference existing, since 1870, between the qualities and methods of using the two weapons. The rifle fires but one bullet at a time, each shot can put but one man "hors de combat" (if exception is made of the very rare case where one bullet pierces 2 or 3 men placed one behind the other), the fire cannot be regulated by observation of shots, the elevation is uncertain, the sighting dependent on many conditions, hence many bullets are lost. The fire being at short distance (less than 1,000 yds.) it is important to get results in a very short time and it is very natural that it is sought to fire as quickly as possible.

Is the same true of the gun? The gun fires, at each round, a shrapnel holding from 200 to 300 balls, the fire is generally at long range and can be regulated with much precision, there will be a great many less rounds lost (if the fire is well regulated). When the range is long there is no necessity of getting the result in a very short time. Finally the ammunition is heavy and of difficult transportation.

We must not forget that for the rifle the increase of fire rapidity has coincided with a strong lessening of caliber and weight of the projectile. It was indispensable or otherwise the difficulty of replenishment of ammunition would have prevented the utilization of rapidity of fire. The total weight of the cartridges carried by each man and by the wagons following the troops could not be increased. It had reached the limit allowed by the strength of the man and that of the already so cumbersome train.

The 11 mm. ball weighed 25 grams, while it has been learned that a ball of about 13 to 14 grams was sufficient to put a man "hors de combat." The number of rounds to be fired could then be increased without adding to the total weight to be carried, and this was done.

Our infantryman carried 80 Albini cartridges weighing 3.360 kg., of which 2 kg. are lead; he carries now 120 Mauser cartridges weighing the same, 3.360 kgs., (1.7 kg. of balls.) The infantry caisson carried 20,000 Albini cartridges weighing 840 kg. (500 kg. of balls); now it carries 26,880 Mauser cartridges weighing 753 kg. (381 kg. of balls). The total weight transported has been subdivided in a little larger number of fragments, each having sufficient dimensions to put a man "hors de combat."

Could the same be done with the field gun? It was proposed, but it was not logical, as the gun fires hollow projectiles, the fragmentation of which is already fixed. If there is some advantage in substituting for a 25 grams' bullet, 2 of 14 gr., each of which produces the same result as one of 25 gr., there is none in substituting 2 shells of 3 kg. for one of 6 kg. On the contrary, there will not be more bursts, and the regulation of fire will be more difficult, without mentioning other inconveniences: the range, accuracy, effect on the obstacles, etc., which diminish with the weight of the projectile. If the shrapnel is considered, the disadvantage of reduction of caliber is still greater than with the shell.

For this reason the rapid-firing guns of small caliber (47-57 mm.) were employed as field artillery only in the colonies, where their lightness was a great advantage, and where it was not necessary to have a gun of very great ballistic power, the adversary generally having no artillery.

On the other hand, employed as field artillery, these guns of small caliber were no longer very light as soon as it was proposed to suppress the recoil to increase the rapidity of fire; the weight of the carriages became then very great.

The idea of adopting these small calibers was almost immediately abandoned, and that of 75 mm. was regarded as the admissible minimum. For some time, however, things were in a bad way, in the sense that, to increase the rapidity of fire, even the weight of the projectile was diminished, but without going so low as in the small calibers. It was desired to lessen the force of recoil in order to more readily make the carriage immovable in firing, without increasing its weight too much. Colonel Langlois in 1892 recommended the shrapnel of 5 kg., and this was the weight adopted by all the gun-makers at that time. The first guns of 75 mm. tested at Brasschaet by Cockerill-Nordenfelt in 1891 and 1892 fired a projectile of 4.7 kg.

Although the governments opposed the idea of lessening the power of the gun to increase the rapidity of fire, manufacturers, none the less, continued to seek the solution of the problem, ending by bringing forth the models now adopted or presented for trial. These models show an incontestable progress. The new guns are superior to those used for about twenty years, but this superiority cannot be compared to that of the guns made after 1870 over the smooth-bores of the 19th century.

The ballistic power has changed but little, the efficacy of a single shot remains almost the same, there is rather a slight reduction in the weight of the projectile. The effective range has not changed either. But the breech fermeture and obturating and firing mechanisms have been notably improved, which has simplified the service, and has allowed, with the introduction of elastic brakes suppressing the recoil, the realization of a great rapidity of fire. This simplification of the service and especially the suppression of recoil present, besides the advantage of rapid fire, that of diminishing the fatigue of the canoneers no matter what the rapidity of fire. Also the progress realized in the construction of artillery material by the aid of private industries allows the hope to be entertained that in the latest models there will be gained in mobility what has been gained in facility and quickness of loading.

Definitely, what is especially changed in the new gun is the facility of employment of that arm, but not its inherent power. The efficacy of its fire could be increased by the rapidity of fire ; but have the circumstances changed in which this rapidity is of advantage? Will it be always necessary to fire very rapidly and to change completely our fire methods, as certain artillerists assert? Since the adoption of the new rifle, has anyone had the idea that the infantry should use *nothing but rapid-fire?*

And there is more reason for using rapid fire with the rifle than with the gun. The former fires but one bullet at each round and is fired as a rule at short distances while the latter fires, at each shot, a shrapnel holding 200 to 300 balls, and is generally fired at long range. And notwithstanding this, many artillerists want to use only rapid fire with the new guns. According to them, the rapidity of ordinary artillery fire must always be the greatest possible, the fire being, it is well understood, intermittent.

In France, the artillery seems to have officially taken this view. The provisional field artillery regulations published in France in November, 1901, attach great importance to rapidity of action which is, according to them, the characteristic of the new gun of 75 mm. and comes from the two essential properties of the new material :

1st. Rapidity and power of fire.
2nd. Possibility of acting by surprise.

They conclude therefrom that fire must be in sudden, short and violent rafales and the fire must necessarily be intermittent.

These regulations are manifestly the outcome of the ideas of Colonel Langlois who in his work of 1892, "Field Artillery in Relation to the Other Arms" insisted on the moral effect produced by sudden losses in a very short time. It is for this reason that Langlois first foresaw these "gusts" of bullets which must sweep the battle field with all rapidity.

The firing methods of the new French regulations can be summarized as follows: 1st, prepare the fire, under cover as much as possible, and act by surprise; 2d, make a wide ranging by salvos of four pieces, so as to bracket the target in a fork (of 100 to 200 m. in general); 3d, fire one or several rafales; after which the fire is interrupted until a new target presents itself or until it is seen that fire must again be begun on the first.

In the rafale, each piece fires a given number of shots without command and without following the order of the pieces. If the command "Progressive Fire" is given each piece fires eight shots changing the elevation for 100 m. after each series of two shots. The rafales or the progressive fire are with or without lateral sweeping (consisting of vaiying the direction after each shot). The quickness of fire for the rafale and for progressive fire is not given in the regulations, but from their spirit, it must be the greatest possible. General Rohne estimates it at 6 shots per piece per minute. The French gun can fire, it seems, 15 to 20 shots per minute, but this is an extreme limit and not of practical use.

The prescription to prepare the fire under cover as much as possible, to open it by surprise, is to be approved without reserve. It is not, however, inherent to the employment of the new guns; it was already contained, at least implicitly, in the Belgian regulations for the 8.7 cm., with respect to the employment of indirect fire.

It is certain that a careful preparation of fire can contribute much to shorten the period of regulation of fire, evidently critical for a battery. As soon as it opens fire, a battery attracts the attention of the enemy and exposes itself to projectiles to which it cannot reply with success except when it can begin its fire for effect. It is thus natural to endeavor to shorten the ranging fire. This was already recognized before the invention of rapid-firing guns. Since the progress accomplished in the construction of time-fuze shells it has been admitted that the ranging can be wider than before. It is not imperative that the mean trajectory should pass exactly through the target; the great depth of action of shrapnel allows of a deviation larger than the probable one.

However, one must not go too far in this direction. Colonel Langlois has well said that time-fuze shrapnel carries to 3000 yards and over, the effects of the old case shot of the smooth-bore guns, but a restriction remains to be made. Formerly to project the case shot to 550 or 650 yards, it sufficed to aim the guns on the foot of the target, with the natural line of sight. Nowadays, to carry this case shot to 3000 yards the sheaf of trajectories should be carefully guided by the battery commander, who must determine with a sufficient approximation the elevation to be used, while the personnel must execute with precision the adjustment of the instruments (elevation, deviation and fuze) and aim with care on the designated target. The regulation of fire requires more care as the distance increases, for the extent of the zone of action diminishes as the range increases.

We can admit that, with time-fuze projectiles, the ranging fire as laid down in the French regulations, is sufficiently precise.

But for the fire for effect there is no visible advantage in these squalls of rapid fire executed in all cases no matter what may be the circumstances and conditions of action and the range.

The Belgian regulations of 1895 for the 8.7 cm. gun, indicate that rapid fire is generally used at distances below 1600 yards and when it is desired to profit of a favorable circumstance momentarily presented. These circumstances are all indicated, for example, in firing against a moving target, when observation of shots shows that the target is at the center of impact; or still better, when the target passes a point on which the fire has been registered. These are circumstances evidently when rapidity of fire is called for. It is already executed as much as possible with the present guns and it will be possible to do it more readily and more efficiently with the new guns.

At short distances (below 1600 yards) it is also natural to fire rapidly. At these distances it is very important to obtain results immediately; observation of fire is very easy; the trajectories are very flat. It can be determined with precision whether the fire produces proper results.

But at long ranges (2700 to 3500 yards) when the fire is against a fixed target, where is the advantage of rapid fire? The moral effect? Major Stappaerts believes that the importance of this effect is exaggerated. Certainly, it is true that a body of troops of which one half of the effective force is put hors de combat in one minute, will be much more demoralized than if the same losses were sustained in 2 or 3 hours. But the use of ordinary fire instead of rapid fire will not give such differences of time.

He supposes that the fire is regulated and that an efficient rafale of 3 shots per gun is fired; this for the French battery of 4 pieces, gives 12 shrapnels or 3600 bullets fired in *half a minute*.

If, with our battery of 6 pieces, we use ordinary fire, these 12 shrapnels will be fired in *2½ or 3 minutes*. Is it believed that the difference of moral effect produced is very sensible? And for this problematic advantage the danger of having no material effect is opened, for example, if an error has been made in the determination of the fork.

Now these errors will be frequent. Already in firing practice how many times do they not occur? It is principally in the first shots that mistakes are made; it is in these that there are more chances of having errors of laying and of observation. Experience proves that, at long distance, the eye accommodates itself better to observation after a certain time; the target, at first difficult to distinguish, is seen more and more easily. And very often it has been seen on the target range, that battery commanders, who had thought their fire well regulated, saw themselves, by the observation of following shots, that it was too much over or too short. Moreover, calculation as also experience proves that even with a ranging fire without error the fire may be wanting in accuracy because of abnormal shots, or shots belonging to the outer limits of the grouping of the points of fall.

If, after the ranging fire, observation of shots is continued, it will always be seen if the fire is poor and it can be be corrected. It is especially when the ranging fire has been brief that it is important to continue the observation of shots in the fire for effect for there will be more chances to see if the fire is inaccurate. Even in time-fuze fire the observation of fire will always prove useful.

But as soon as rapid fire is commenced, observation of fire can no longer be made. At the most can it be seen, in certain cases, after a rafale fired with a single elevation, that the fire was too much over or too short. But if the rapid fire has been made with progressive fire the pieces firing with different elevations and without following any order, *all observation is impossible*. And according to the French regulations, the fire for effect will probably be most frequently executed with progressive fire. (Of 24 examples of fire given in the regulations, there are 14 where progressive fire is ordered.)

Progressive fire is much thought of nowadays, not only in France, but by almost all the partisans of rapid fire. It is not necessary, however, that the gun be rapid-firing to cover a zone of a certain depth by salvos with "echeloned" elevations. The Belgian regulation, of 1895, for example, recommends this kind fire in cases where direct observation is impossible, especially when the target is hidden by a crest or other cover.

But this fire used exceptionally when it is not possible to execute ranging fire by direct observation of shots, is to-day recognized as advantageous in most cases, even when direct ranging would be quite possible. One is carried away by the desire to produce immediate results and by the extent of action of the projectiles now in use. With time-fuze shrapnel, containing 200 to 300 balls, it is sufficient that about a dozen should be fired with good elevation, to produce the desired result. If 40 are fired, with 4 different elevations varying by 100 m., there are chances for 10 effective hits giving the desired effect in less than a minute.

There are chances, it is true, but the apparent certainty given by the ranging is not there. The 40 projectiles will cover with bullets a zone about 400 to 500 meters deep, so that if there is an error of 250 meters in the range, the target is not in the zone of dispersion any more and the result is nil. Admitting the favorable case where the target is in the zone of dispersion, 40 projectiles will have been fired when 10 could have given the same result; that is to say, four times what was necessary.

It must not be forgotten that the weight of ammunition for the field gun has not diminished and that the total weight to be transported can be increased but little.

In France they have succeeded in carrying in an army corps, 501 shots per piece, but this is secured by reducing the batteries to 4 pieces, that is to say, one-third of the guns has been done away with and replaced by ammunition wagons; yet the total weight of ammunition transported is but little greater than that transported by the German army corps where they have 344 shots per piece but where the battery is of 6 pieces.

The total number of available rounds not having been increased much with the adoption of the new guns, there is no reason to be more prodigal than before in the consumption of ammunition, *when the conditions of the battle do not exact a great rapidity of fire.* These conditions shown above, from the Belgian 1895 regulations, have not changed since the adoption of the new guns.

The last German firing regulations, published in 1899 and treating of the employment of the gun, model of 1896, says: "the tactical situation only decides the rapidity of the fire."

In these regulations the rules of fire remain the same, except in a few details, as in the regulations of 1893, which are very similar to the Belgian. The ranging is done with the same exactitude as before. It is recommended that the fire be conducted as quickly as possible, but subordinating the rapidity of fire to the possibility of observing each shot and making each time the necessary correction. In regard to the fire for effect after ranging, its rapidity depends on the tactical situation. The ordinary fire is 6 shots per minute to a 6-gun battery.

It is true that the new German gun is not a true rapid-firing gun, as is the French gun ; its maximum rapidity of fire is about 8 shots per minute. For that reason it is called an accelerated fire gun.

Major Rouquerol, in his book on the tactical employment of R.F. field artillery, says that the importance of the maximum rates of fire must not be exaggerated, when they reach 8 shots per minute. On page 17 can be read : If the fire is regulated and effective, it will immediately disorganize the enemy, whether the rapidity is 8, 10 or 12 shots per minute. "If it is inaccurate or if it is ineffective, from any cause whatever, its rapidity has little importance ; on the contrary, the most rapid fire will be the most disadvantageous from the point of view of wasting ammunition."

Therefore, the lecturer believes that the new German gun, although only accelerated-firing, is perfectly capable of holding its own against the French rapid-fire gun.

When each shot projects 300 bullets, it becomes altogether superfluous to fire a very large number of rounds in a very short time, on a target corresponding to the objective of a battery. The consumption of ammunition must be proportioned to the effect to be produced, under danger of running to waste.

But above all we must not abandon the precious faculty possessed by artillery, since 1870, of regulating its fire with certainty by observation of shots.

The new German regulations do not give up anything in this respect. In the new French regulations, on the contrary, the ranging is shortened and by the rapidity of the fire for effect there is taken away the possibility of rectifying in time, any error which may be made in this brief ranging.

These last regulations are inspired by the ideas of Colonel Langlois, given in his work of 1892. In fact, Langlois says, (p. 398,) that "the method of shrapnel-fighting must be wide ranging, prompt and sure, followed by fire in echelon at maximum rapidity." Then, further on, the same page: "Fire by rafales is the tactics of case-shot fire of the old artillery (smooth-bore), acquainted with war from having had much practice therein."

It must be noted, however, that smooth-bore artillery in its case-shot fire at short range was sure of its effect, while at 3500 yards, wide and prompt ranging is not sure, no matter what is said. If it is necessary to expend much ammunition in the decisive moment of a fight, at short range, it is necessary to be very saving of it at 3500 yards and never to fire with all rapidity at these distances.

Major Stappaerts adds that while Colonel Langlois attaches great importance to the ranging, he tries to shorten it, but he does not speak of doing away with it and, on this point also, the new French regulations agree with him.

But some artillerists seducted by these ideas, exaggerate them and go much further. They go as far as prophesying the complete abandonment of firing methods based on observation of shots, which have allowed field artillery to make practical use of the long ranges of rifled guns. Some articles which have been published in the military press acquaint us with these ideas of some of these partisans of rapid fire.

They want at any cost, to get an effect immediately from the moment of opening fire and to accomplish the destruction of the target in the shortest possible time. For them, the ranging causes too great a loss of time ; even the determination of a fork delays too much the action of the furious storm of iron and lead which should beat down the enemy at the moment he least expects it, and destroy him before he has time to see anything.

According to them, when one has at one's disposition guns capable of firing in one minute 15 to 20 projectiles holding each 300 balls, when one can, by perfected laying arrangements, vary in quantities exactly determined, the direction and elevation of these guns in a few minutes, one can cover with a rain of bullets all the zones where the enemy may be found. There is nothing more to be done but find some learned methods for the determination of the elevation by the aid of observation round after round.

The distance is estimated by sight or it is measured (on the map or otherwise) and salvos or rafales methodically echeloned are fired so as to cover with case shot a depth of 800 m. and more if necessary, so that no matter what error has been made in the range, the target is in the zone swept. The fire must naturally be very rapid because only a small fraction of the shots fired can be effective and it is necessary that the destroying effect be produced instantaneously.

Here the consumption of ammunition reaches much more than four times what is necessary.

According to these partisans of sudden and violent rafales, the artillery will hardly be able to use any other method of fire, because on future battle fields troops will remain hidden, the artillerymen will see nothing and will have to content themselves with firing on the zones where the commander knows that the enemy is preparing himself and assembling. It will then be necessary to cover these zones sufficiently thick with shrapnel to prevent the adversary from finding any point where he is sheltered.

Others even go so far as to pretend that this somewhat mechanical fire, where man intervenes the least possible, his function being limited to adjusting the sighting apparatus of a perfected carriage, will give better results than that depending on qualities of science, calmness, and discipline of officers and cannoneers.

This point is very much discussed, but we will only ask what consumption of ammunition would be brought about by the systematic execution of such methods of fire.

Some few years ago when rapid-firing field guns were first spoken of, some fears were felt regarding the waste of ammunition. It was answered, with reason, that this waste was much less to be feared with guns than with rifles, because the battery commander will always remain master of the conduct of the fire. This is correct but with the adoption of methods of fire laid down by those who would suppress the ranging, the battery commanders themselves will organize and direct the waste.

For these partisans of rapid fire, the rapidity will never be too great ; for them the best gun is that which allows the greatest rapidity of fire. They want 15 to 20 shots per minute and more if possible, and they speak disdainfully of guns firing 8 to 10 shots per minute and those which are accelerated-firing only. It might truly be said that the fever of speed seen since the past few years in commerce and the world of sports is propagated even in the artillery.

It is impossible to see any progress in this systematic employment of rapid fire with the field gun.

No supply of ammunition would permit the complete application of such fire on zones unseen but which must be covered with shrapnel fire as thickly as possible. The enemy could always mass more closely and await till the exhaustion of ammunition brings the end of the rafales. The non-effect of these cannonades to the uttermost on invisible targets, has been seen in the Transvaal. True, in the fights of the future it is probable that the two adversaries will try to hide themselves as much as possible, which will be facilitated by the use of smokeless powders. But it will be necessary for the assailant to end by showing himself if he wants to advance and for the defender to let his emplacements at least be seen if he wants to repulse an attack.

He will be the stronger who will have reserved his ammunition for that moment, instead of expending it in raining shrapnel over these zones where the presence of the enemy is hypothetical.

The lecturer believes that it is only altogether exceptionally that field artillery should fire without the battery commander seeing the target and observing the the fire. The case will be presented, for example, for a few batteries in a fight of the vanguard, to facilitate the reconnaissance by the latter of the position of the enemy. And later, if it is seen that hostile batteries are established behind a crest over which they fire. Yet in this case a ranging fire on the crest is executed. Besides it will not be useful, in such cases, to act *with all rapidity* nor to expend an enormous quantity of ammunition.

According to his opinion it will always be a fault to expend 100 projectiles when 10 would be sufficient to produce the same effect. But besides he believes that if these 10 are fired in observing each shot and following the rational methods of correction, there are many more chances of really producing the desired effect than if 100 shots are used in rapid firing, trusting to the exactness of a measurement of the range and the dimension of the zone covered.

Briefly, he believes that the adoption of the new guns must bring in our methods of fire only modifications of details but that the principles must remain the same.

Rapid fire must be used only in the cases indicated in the Belgian Regulations of 1895, that is, *generally* at ranges below 1650 yards, and *sometimes* at greater ranges *when the tactical situation indicates it* (moving target).

The rate of rapid fire will naturally be greater with the new guns than with the 8.7; but it must never exceed 8 shots per minute per piece. The duration of such rapid fire should be very short.

If rapid fire was made the habitual fire of field artillery we would learn fatally to neglect the observation of the points of burst and to abandon the determination of elevation by direct experience.

One must certainly not lose time by too minute a ranging. The ranging can be wide, but it is absolutely necessary that the fire be always conducted by means of corrections resulting from the observation of the shots and not by reliance on estimations of distances, topographical operations and the extent of the zones covered by an echeloned fire.

The day when the artillery will cease to make use of the precious quality of correcting its fire by the observation of each shot, it will lose the principal quality which renders at long ranges the fire of the field gun superior to that of the rifle and machine guns.

These two weapons have to-day a range of more than 3000 yards. Machine guns, like the field gun, have the advantage of steadiness of the carriage and stability of laying and are more mobile than the field gun. They fire only one bullet at each shot, but their great rapidity of fire (10 shots per second) enables them to strew the ground thickly with bullets, which can be projected to 3000 yards and be distributed methodically. Only the fire of machine guns can not be regulated at long ranges by the observation of shots, so that their fire would not be guided on the target but dispersed by chance.

This is why the attempts made to use machine guns at long ranges and to make them take the place of artillery, have always failed as have the attempts to make practical use of the long ranges of the rifle. The field gun alone is useful for fire at long range, let us not make it lose this quality. Let us not make it a machine gun.

There is also an element of mental order which is to be put on guard against the abuse of rapid fire. Calm and coolness are at present fundamental qualities in the field battery. The whole personnel, grouped around the 6 fixed points made by the guns, is in the hands of the non-commissioned officers, the whole is in the hand of the battery commander. In the *ordinary fire* (4 to 6 shots per minute for the battery of 6 pieces) it is really the will of the battery commander which directs the six trajectories; everyone is paying attention, all the operations of loading, adjusting the instruments, sighting, and laying, are carefully performed and the chances for errors are reduced to a minimum.

In *rapid fire* the calmness ceases, even with the best trained personnel. The direction of the fire passes from the battery commander; each piece fires by itself, under the direction of the chief of section. The personnel will be the more enervated as rapid fire is the more frequently used. The errors in adjusting the instruments and in laying will increase the causes of irregularity in the fire. Even with the pieces the carriage of which is motionless, as the French gun, man must constantly intervene to modify the elevation in progressive fire, the direction in sweeping, to rectify the laying at each shot (for the immobility is never absolute). It is necessary that the fuzes also be cut in accordance with the elevation.

How many errors are made in the hurry (not to say madness) of rapid fire at its maximum rapidity. And all this will be so much graver as the non-observation of shots will not reveal the errors and the personnel will naturally be less attentive, feeling itself less under control. It is to be feared that the fire will be very poor.

On this account Major Stappaerts believes that we must carefully guard against abuse of rapid fire in field artillery, under pain of seeing the artillery fail in its rôle in the fight. In contracting the habit of firing rapidly, the habit of firing well will be lost and we risk witnessing a multiplication of those vain cannonades, many examples of which we have from the last wars, firing tons of iron and lead with much noise, but without producing any results.

NOTES ON THE ARTILLERY IN THE SOUTH-AFRICAN WAR.

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TRANSLATED BY CAPTAIN WILLIAM LASSITER, ARTILLERY CORPS.*

In its number for July 1902, the Revue Militaire Suisse has given an analysis of an article of the "Revue des Deux-Mondes," entitled: Some Teachings of the South African War. While stating that the conditions under which this war was carried on are of too special a nature to permit positive solutions to be deduced, this article seeks to show that much instruction may be drawn from it; that the fire from rapid-fire guns using smokeless powder has forced the English to abandon their former methods; and that new tactics have been necessitated and improvised. This point of view has received, moreover, an immediate practical confirmation, inasmuch as we read, in the *Chroniques* of Germany, accounts of the new German infantry tactics inspired by that of the Boers.

We seek then to draw from the South African war such teaching as it can give on the evolution of tactics, consequent upon the improvement in fire arms.

These teachings affect especially the infantry, in view of the leading rôle played by the infantry rifle in this war. But if the rather secondary rôle played by the artillery prevents us from drawing precise conclusions concerning that arm, the examination of certain facts concerning it, and some opinions which these facts have suggested, do not fail to claim a certain interest.

This examination is the object of the following pages; it does not however claim to be complete; for though the publications on the war are already numerous, the principal documents, such as the work prepared for the English general staff by Lieutenant-Colonel Henderson, and the Boer documents, whose publication General Botha proposes, have not yet appeared.

One must not, however, forget the very sensible difference existing between the rapid-fire artillery everywhere under test today, and the material employed in this war; a difference which will prevent us from making absolute forecasts concerning the future of artillery.

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* Revue Militaire Suisse, January and February, 1903.

We will first take a rapid glance at the equipments of the two belligerents, and at their effective strength.

Then we will note the respective forces of artillery present in principal battles. After having described the method of fighting generally employed by the two adversaries, we will permit two actual witnesses to give their special observations on the artillery: First, Captain Holmes Wilson, of the Royal Field Artillery, who took part in the fights on the Tugela; then, a German officer who fought on the side of the Boers in the Orange Free State. These two witnesses, while telling only of things seen, will not repeat one another too often. They did not belong to the same side, and they have figured on two portions of the theatre of war, whose terrains were not identical.

Finally, we will quote from Captain Gilbert, who, in his posthumous work, La Guerre Sud-Africaine, seeks to draw the lessons of the campaign. This work deserves to be read and meditated upon, and the extracts or resumés which we shall give are intended merely to invite our comrades to study it. They will find there, among other things, a very interesting chapter of conclusions.

The author, enlarging upon his subject, branches out into a discussion of the rôle in war of the new artillery, and takes for that purpose the method adopted by General Langlois, commandant of the 20th French Corps in his book of 1892: "Field Artillery in Co-operation with the Other Arms." The principle, indeed, indicated by this title will be the one which he will strive to emphasize by the lessons of the campaign.

This article will not extend then into a discussion of the points of view expressed. It will limit itself to being objective, and to putting before its readers some facts and opinions furnishing matter for reflection.

I. MATERIAL.

Let us take a glance at the material employed on the two sides.

We find on the part of the English:

The field piece of 76.2 mm. (3-inch) of 1884, improved in 1895 at the time of the introduction of smokeless powder. From the point of view of ballistics, we may consider it as closely analogous to the German piece of 88 mm., or the French piece of 80 mm., or even to our present Swiss .piece. Only shrapnel were provided for use with it. These shrapnel contained 200 balls, and had combination fuzes adjustable up to

3650 m. The piece fired from one to two shots per minute, with an initial velocity of 471 m.

A recent arrangement of Colonel Clark has permitted the partial suppression of the recoil, and the transformation of the piece into one with accelerated fire, capable of five shots per minute.

The piece of the horse batteries, of the same caliber, very light; furnished with shrapnel, also very light, interchangeable with those of the field piece; this interchangeability did not exist for the charges.

The mountain gun, which fired a seven-pound shell, of little effectiveness.

The field howitzer of 12.7 cm. (5-inch), heavy for a field piece, provided with shrapnel and lyddite shell, with a maximum range of 4900 yards.

The siege pieces, principally of 15.2 cm., but some of 12.5 cm. and of 10 cm.

The navy pieces, some fired from platforms, others from carriages improvised at the last moment for their transport. They were of calibers 15.2 cm., 12 cm. and 7.6 cm.

Finally, some Maxim machine guns, distributed by sections of two pieces each to brigades of infantry and cavalry, and to battalions of mounted infantry. At first these were machine guns using small arm ammunition.

Later, when the English had seen the moral effect produced by the Boer pom-poms of 37 mm., they too procured some of these machine guns of larger caliber. They reached the army just before the surrender of Paardeburg.

The lyddite shell of the howitzer weighs 25 kg. (50 lbs), and its explosive charge 4.5 kg. The cone of dispersion is 180 degrees, which, with accurate fire, permits reaching behind cover; but the effect is inconsiderable against shields, due to the smallness of the fragments.

As for the number of guns in use by the English, this has varied with the different epochs, always increasing with the successive mobilizations caused by the first checks in Natal and on the Modder.

Here are the totals at different dates;

For the regular army:

October 7, 1899. Total on the line covering the mobilization, 66 guns.

December 10, 1899. Re-enforcements of three divisions and one mountain battery have arrived. 186 guns, of which 18 are howitzers, and 20 machine guns.

January 1, 1900. A fifth division has arrived, and a group of horse artillery. 222 guns, of which 18 are howitzers and 29 machine guns.

March 1, 1900. Re-enforcements: Sixth and seventh divisions, and four groups of horse artillery, of which one of howitzers. 338 guns, of which 36 are howitzers and 65 machine guns.

April 8, 1900. Re-enforcements: Eighth division. 356 guns, of which 36 are howitzers, and 81 machine guns.

In taking account of volunteers and colonials, these totals become: 407 guns, of which 36 are howitzers and 144 machine guns.

It is proper to add the siege train, debarked between the 15th and 25th of December, and composed of 30 howitzers; then the detachments from the navy, whose total in guns is not given; the first three at Ladysmith on the Modder and the Tugela comprised about 30 pieces.

Let us recall that the total effective strength dispatched to Africa amounted, on the 10th of April, 1905, to 200,000 soldiers and 4,000 sailors, and at the end of the campaign to 448,000 men.

On the side of the Boers, artillery troops formed the only permanent nucleus, both in the Transvaal and the Orange Free State. The effective strength was about 800 men, with some reserves. Data concerning the material at their disposal has greatly varied. According to a report of the war office of February 11th, it was estimated at 220 or 230 guns; but there have been included in this estimate, orders given and not filled; and according to the Revue Militaire des Armées Etrangères (April, 1901), the material comprised only the following pieces:

Transvaal:	4	siege guns,	155 mm.	Creusot.
	6	field guns,	75 mm.	Creusot, 1895.
	8	" "	75 mm.	Krupp, 1896.
	4	howitzers	12 cm.	Krupp.
	3	field guns,	75 mm.	Maxim-Nordenfelt.
	11	field guns,	75 mm.	
	8	machine guns,	37 mm.	Maxim-Nordenfelt.
	14	" "	using infantry ammunition.	
Orange Free State:	14	field guns,	75 mm.	Krupp, 1892.
	6	" "	Armstrong muzzle loading.	
	3	mountain guns, Armstrong.		
	1	machine gun,	37 mm.	Krupp.
	3	" "	using infantry ammunition.	

If these figures are correct, we have then eight pieces of large caliber, 38 field pieces, 3 mountain, 9 pom-poms and 16 machine guns using infantry ammunition.

The Krupp piece was analogous to the present German material with accelerated fire. That of Creusot approached the French rapid-fire gun, without having its accuracy and not possessing its shields. Both, without being entirely up-to-date, were superior to the English pieces in range and rapidity of fire. The Krup material, while inferior to that of Creusot from the point of view of ballistics, seems to have been preferred by the Boers on account of the superior quality of its ammunition. The field pieces had both shell and shrapnel. The Maxim-Nordenfelt could throw 50 to 60 shell, of from one to two pounds each, per minute, and carried shields. A part of the ammunition had fixed metallic cases. The Boers, like the English, used smokeless powder.

The effective strength of the army at the beginning of the campaign has been estimated at 50,000 men; but in taking account of all the men who left the commandos to return home, the present effective never passed 36,000 to 38,000 men. This would be then the strength of an army corps, with a proportion of artillery half that of an army corps of the great countries of Europe, and spread moreover over this vast theatre of war.

II. STRENGTH OF ARTILLERY IN THE VARIOUS BATTLES.

In referring to the historical works of the war for the complete description of the rôle played by the artillery in the principal fights, it is worth the trouble to go over the lists of each and note the number of guns which are found available on either side. If this is easy with respect to the English, the same information concerning their adversaries is not at all precise or reliable; nor do the reports always agree.

The army of Joubert on entering Natal comprised 16 field pieces, besides some pieces of varied type, among which the celebrated Long Tom figured. Sir G. White opposed him with 6 field batteries, one mountain battery, and one colonial battery from Natal; in all 48 pieces. Note the following details: At the first encounter of Glencoe, October 20th, the Boers after having surprised the English camp by a fire of artillery, abandoned Talana Hill before the English attack; they had only 4 guns and 2 Maxims against 18 English pieces. The next day, October 21st, at Elandslaagte, we find two pieces pitted against the Natal battery at first and then against 12 additional field pieces. At the affair of Rietfontein, October 24, the only Boer piece which opened fire against the English column in march, withdrew afterward before 12 pieces. Impressed from the first encounter with the fact that the range of the Boer artillery surpassed that of the English artillery, General White telegraphed at once for navy guns. The first detachment of these arrived at Ladysmith, October 30th, just in time to take part in the battle which preceded the investment of the place. On this day Joubert probably put in action all the artillery he possessed against the 7 English batteries. The latter energetically defended the retreat, supported by the 3 navy guns which debarked from the train to open fire. One of these was overturned by a projectile from Long Tom; but the others, thanks to the effect of their lyddite shells. a novelty for their adversaries, did not fail to gain the advantage. On the same day, the mountain battery, as well as the detachment of Nicholson's Nek, fell into the hands of commandos unprovided with artillery.

The army of Cronje on the Modder had 10 guns. Lord Methuen while attacking him, had his army successively reinforced.

In the fight of the advanced line at Belmont, November 23, two Krupp pieces and the pom-poms of Major Albrecht which, the evening before, had retired behind kopjes before an English reconnaissance, did not take part in this struggle. On the part of the attack, there were two batteries and 4 navy 12-pounders. On the 25th at Graspan, 6 Krupp pieces, 1 Nordenfelt and 1 Maxim supported the contest for three hours against the same 16 English pieces.

On the 28th, at Modder river, Major Albrecht had disposed 5 pieces in the center, 2 on the right wing, 2 on the left with a Maxim, and had them all sheltered behind strong epaulments. He had, besides, a Hotchkiss, intended to be posted according to the course of the fight. Lord Methuen, reinforced by a battery, had 22 pieces.

When a little later he sought, on the 11th of December, to force the last point of support of Cronje at Magersfontein, he had 3 field batteries, 1 horse battery, 1 battery of howitzers and 5 navy guns, of which one was of 15 cm. caliber. In this battle, commenced at night by the attack of the Scotch brigade under General Wauchope, the Boer artillery, apart from the pom-poms, did not make itself heard until 4 o'clock in the afternoon. At this moment, the sudden opening of its fire determined the retreat of the Scotch, who had remained in place after their check of the morning.

The Boer artillery seems to have played an even slighter rôle in Orange than in Natal. We have proof that General Cronje had very little artillery; for after having left one piece at Magersfontein at the time of his retreat on Paardeberg, he gave up, on his surrender, only 4 Krupp field pieces and 2 pom-poms. He had, then, no heavy calibers, and scarcely could he use his 4 guns, when he found himself exposed in his camp at Paardeberg to the fire of more than 50 pieces, among which were field howitzers and navy guns.

Of their 4 heavy 15 cm. pieces, the Boers had one before Mafeking, one before Kimberly, and two before Ladysmith. If we add a few pieces before these two places, and a few others with the troops in the south of Orange, we arrive at about the total effective strength indicated above.

In the second phase of the campaign in Natal, General Joubert distributed his artillery between the defense of the Tugela and the siege of Ladysmith. A map of the siege in "Naval Brigades in the South African War," indicates before this place ten emplacements for siege pieces, besides five for field pieces. This figure must be a maximum, which has scarcely been reached at any one time.

General White had received, as we have sen, some navy guns to reinforce his seven batteries. There were two 15 cm. pieces mounted on wooden platforms; four 12-pounders, of which three were mounted on Scott improvised carriages, the other being a landing gun; finally 4 Maxims, of which three were on carriages and one on a tripod. It must be remarked, however, that this superiority was only relative in view of the limited ammunition supply, which forced the besieged to a great economy, especially toward the end of the investment. The two 15 cm., for example, had only 300 rounds each.

In the combats on the Tugela, we find at the beginning, at Colenso, December 15th, 5 field batteries and 12 pieces of heavy caliber (2 of 15 cm. and the others 12-pounders), against 9 Boer pieces (5 only according to Gilbert) and some pom-poms. Afterwards, at Venters Spruit and Spion Kop at the end of January, at Vaal Krantz and Pieter's Hill in February, the English artillery was further increased. The Boers, to counterbalance their inferiority detached on occasion, pieces from the siege of Ladysmith. Thus at Vaal Krantz we see a Long Tom playing an important part. They also called Major Albrecht from the Modder to Natal, with half of his artillery. This remarkable utilization of interior lines is established by a letter of Major

Albrecht's.* This assistance was only temporary. Thus the disproportion of forces went on increasing, and when the English forced the Tugela at the moment when the Boers commenced the retreat and then raised the siege of Ladysmith,—both occasioned by the surrender of Cronje at Paardeberg,—we see the attack on Hilongwane Hill prepared by the fire of 64 pieces against only 3.

III. METHODS OF COMBAT OF THE BELLIGERENTS.

In order to understand better the manner in which the material was utilized, it is useful to bear in mind the nature of the organization to which it pertained. Here is the description of the method of action of the Boers, given by Captain Gilbert, and condensed in a few words: "After having taken the initiative and the strategetic offensive in their invasion of Natal, they limited themselves to a purely passive tactical defensive.

"Their disposition for battle was always linear, without organization in depth,—save sometimes an advance line,—and without reserves. So, to reinforce a point or extend the line, they had no other resource than to withdraw men from the part of the line least menaced,—a proceeding rendered possible by the mobility of the troops, which were always mounted. Their victories were always sterile because they contented themselves with parrying without thrusting. because they did not know how to pursue a beaten enemy. These tactics, which check the enemy but do not crush him, were almost imposed upon them by the lack of organization,—they know only the commando,—by the lack of discipline, and finally by the very slender effective strength, with which they opposed the English."

A letter from a companion of Villebois-Mareille in the Journal des Debats attributes a great part of the offensive weakness of the Boers to the election of officers by their men, a principle which must have often paralyzed the initiative of the chiefs: "It is well enough as long as the electors and the elected are in a communion of ideas; but when the elected thinks to execute a plan which is not agreeable to those under his jurisdiction, he approaches the danger of being cast aside and replaced by a member of the majority."

The Boers, convinced by experience, renounced this system later, and decreed, September 14th, 1900, a true military organization in which the generals and commandants were named by the commander in chief, the field cornets by the commandants, the corporals by the field cornets. But this organization was only able to figure in the guerilla warfare, with which we shall not occupy ourselves here.

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*See Journal de Geneve, February 11, 1900.

The German officer, to whose testimony we shall recur later, characterizes thus the Boer method of fighting: "Their general principle was to seek to envelop the adversary, or at least to avoid being themselves enveloped; that led them to a considerable extension, and, consequently, to a very weak occupation of their own lines. The envelopment of the adversary is advantageous, for this mode of fighting favors the effect of one's own fire better than any other by concentrating it, and neutralizes at the same time the enemy's fire by forcing it to be scattered. Often they have committed the fault of not utilizing the results obtained, and pushing forward while continuing the fire; but it would be an error to impute their passivity to extended formations alone. Good commandos, led by energetic chiefs, have often proved the contrary."

We will understand, then, without difficulty that with their small number of pieces, their lack of organization and their very extended fronts, the Boers have employed their artillery only by isolated pieces. These general conditions have prevented them from realizing the unity of action desirable between artillery and infantry.

On the part of the English, without being a party to the same parcelling of forces, we find that the superior unit of artillery does not exceed the group of three batteries attached to each division of eight battalions. There is lacking, then, a fixed organization of command for the direction of the fire of great masses. Captain Gilbert thus describes the English method: "To start with, their plan of engagement is purely linear like that of the defense. No reconnaissances, no advance guard action; and in place of utilizing the passivity of the enemy for a turning attack or distributing their troops with a view to carrying some decisive point, they deploy their forces prematurely before the whole front. It is scarcely in such a method of conducting battle that one will find teachings for artillery."

IV. OBSERVATIONS OF CAPTAIN HOLMES WILSON.

One of the first facts which struck Captain Holmes Wilson as well as the whole English army, from the time of the first encounters in Natal, was the superiority of the Boer artillery material over the English material. If this superiority has not played a more important rôle, it may be attributed to the small number of cases in which the Boers could act by concentration of fire upon a single point for a definite time, to the defective quality of their ammunition, and finally to the too restricted number of their pieces.

This superiority has, first of all, affirmed itself by a greater range. The English field artillery found itself exposed more than once without being able to reply not only to the fire of pieces of heavy caliber, but even to that of simple field pieces. Examples are not lacking. At Spion Kop the deficiency of range prevented 40 English pieces from supporting a decimated infantry by their fire. Likewise, at the demonstration of the 24th of January, before Breakfontein, immediately before the attack on Vaal Krantz, six field batteries suffered in the open the fire of an enemy out of reach. Two days later, when the Long Tom appeared at Dornkloof, the inconvenience of the deficiency of range becomes still more sensible ; here it is the field howitzers of 12.7 cm. which are not able to reply. The Long Tom was posted on a high hill and completely under cover ; it was especially necessary to resort to the curved trajectories of these pieces to have a chance of hitting him. Mounted on a disappearing carriage, the duration of his appearance when he fired was very short; the projectiles of the heavy navy pieces, whose range was alone sufficient, owing to the great time of flight for the distance, always arrived after his disappearance; and due to their comparatively low angle of fall, struck the parapet or passed over without ever being able to reach behind the shelter.

The case of the battle of Mooi River is still more characteristic on account of the moral effect produced. There the Boers utilized the great range of their artillery to surprise their adversary, as they had already done at Glencoe. After the investment of Ladysmith, they had pushed a strong reconnaissance to the south of the Tugela ; one of their detachments, with one or two pieces, surprised General Barton's camp of all arms at Mooi River, and at 4500 yards, threw shells into his tents—somewhat as the Prussians did at Beaumont in 1870. An English officer present at this affair, after having described the very uncomfortable effect which this surprise had upon those who suffered it, adds : "Then our battery dashed at a gallop out of camp and we said to ourselves : Now the Boers are going to see that they have gotten themselves into a wasp nest ; and we waited impatiently for what was going to happen. The battery opened its fire ; that of the enemy was turned against it. No great harm was done the battery ; but what was our surprise to see our six pieces obliged to stop firing because they were outclassed in range. As the ground, all cut up in ravines, rose rapidly beyond, they could not advance. Can one be astonished that our beautiful confidence was somewhat shattered, after having seen 500 of the enemy bombard a camp of 3000 men at mid-day with impunity".

Two objections may be made against the fire at long distances. The first is this: The entirely exceptional transparency of the air in South Africa which favored long distance firing will not be found elsewhere. This is evident for England. However, there are other countries where the conditions of visibility will also be very favorable: Egypt, the East, Greece, where in the last campaign, fire was delivered at 7000 m., while observing the shots perfectly. The second is more serious: The remaining velocity of the shrapnel balls at great distances is insufficient to produce the necessary effect. This objection is supported by facts observed in the war. Thus, apropos of the six batteries which we have just seen exposed to the enemy's fire before Breakfontein, Captain Holmes Wilson relates how, after having fired two hours without reply, they were suddenly subjected to a fire of artillery.

"When they saw projectiles bursting over them without being able to reply, the troops were seized with dismay, asking themselves if they were going to take part in a repetition of the Colenso disaster; but when the smoke had blown away, it was found that there were no casualties. Long range shrapnel fire of field pieces had just shown itself entirely inefficacious".

The superiority of the Boer material has further shown itself by its greater rapidity of fire. Our witness has seen at Breakfontein, three Boer pieces hurl more projectiles at six English batteries, than six English pieces could have thrown with their most rapid fire. He adds that the same day the slowness of the English fire permitted a Boer piece to be withdrawn and a pompom advanced without being disturbed. These are brief opportunities; they often present themselves and it is necessary to be able to take advantage of them. The author believes then, for such cases, in the great superiority of a battery of 4 rapid-fire pieces over the English battery of six pieces.

Let us pass now to the utilization of shelters and of natural cover. The Boers made such a skillful and constant use of this factor that we may attribute to it a rôle of the first order in the campaign. The long halt of the army of Sir R. Buller on the

Tugela, is it not principally due to the art displayed by the adversary in remaining completely invisible?

The check to the attack of Lord Methuen at Magersfontein, is it not due to the same cause? On the other hand, is it not because they did not know how to employ this factor that the English were driven from Spion Kop, and that they saw the war prolonged for so long a time? The author does not hesitate to find in this the secret which permitted an adversary, incapable of resisting a month in the open, from keeping the field for years; and, especially, which permitted his artillery, so inferior in numbers, to keep from being annihilated. The disposition of his artillery by isolated pieces, so open to criticism from many points of view, has had this advantage, to permit of their being concealed very much better.

So one of the principal tasks of the English artillery has been to discover the emplacements of the enemy's guns. It was not rare to see the other arms come to its assistance for this purpose. If one wishes to determine the different places from which, at variable intervals, bluish flashes are going to appear, —which one cannot foretell in advance—it is necessary that a large portion of the terrain be constantly watched; and for that, one pair of eyes is not sufficient; a very great number are needed.

Seeking cover everywhere and always has been the first principle of tactics of the Boers. Two circumstances have permitted its excellent application; long range guns and, especially, absence of smoke. What are we to think of the value of this principle? If it is dangerous to be always having recourse to it, it is evident that, wherever it can be applied, it will prolong the duration of the struggle. Up to that time, the English artillery exercising and maneuvering always in the open, had neglected it; but it was not forgotten elsewhere. Thus the German regulations say: "It is always desirable to protect one's self against the enemy's fire by throwing up works as soon as there is time, even in an offensive action." And again: "Any kind of work is good if it serves to render more difficult the enemy's observation."

So the author asks what would happen to the English artillery if it found itself opposed to Prussian artillery having recourse to cover—unless it intends to do likewise.

At Colenso, all the Boer guns were sheltered and most of them invisible. At Spion Kop, not a single one could be distinguished. At Vaal Krantz, as we have seen, the only one which was perceived, the Long Tom, was so well protected that nothing could be done against it. At Pieter's Hill all were under cover and invisible. Formerly it was thought that the first gauge of success was to accomplish the regulation of fire first. This first gauge today might well be taking shelter. If artillery in taking a position to the front, falls under the fire of invisible batteries, which of the two sides will have the upper hand? The answer does not appear to be in doubt. So the author concludes from this that a delay in opening fire, in order to gain the necessary time to prepare shelter, will be almost always advantageous.

Another question: What is the effect of artillery on shelters and on the troops behind shelters? On the Tugela, where the Boers constructed many works, the effect of fire of field pieces, like that of the heavy calibers, field howitzers or 15 cm. navy guns, was nil. One might readily foresee very slender results after experience on the practice ground; but this appears to have been a revelation for the English artillery which, according to the author, had never previously practised firing at targets under cover.

How is it that this effect has been nearly nil in reality? For the works, the damages were rapidly repaired at night; as for the men, under the fire of artillery, they remained hidden. As soon as the infantry of the attack approached and the bombardment slackened, they lined the trenches and decimated their adversary. To the question: "What will artillery do if its fire is so ineffective against shelters?" The author answers: "The occasions for using shrapnel will be much more rare; we must turn to the study of another projectile and have recourse to heavy calibers."

We will see Captain Gilbert treating this question in a more general manner and giving to it another answer, which he considers one of the principal lessons of the war. So we shall take up this point at greater length at the end of this article.

With regard to mobility, Captain Holmes Wilson states that the navy guns and the field howitzers have shown themselves sufficiently endowed with this quality, even in a country devoid of roads. He sets forth the importance of this factor for heavy artillery which must follow the army. And is it not heavy artillery which, in a terrain like that of the Tugela, has been obliged to open the combat? However paradoxical it may appear, heavy artillery then must be able to open fire first and cover the advance of the other arms. With a field artillery provided only with shrapnel and not able to fire at great distances, the commander of an army will not be able to attempt the least attack before the arrival of his heavy artillery. In this regard, he remarks that we will return to the idea, abandoned in 1870, of keeping some artillery in reserve. For what good will it do to push guns to the front at the beginning of an action, only to expose them to a fire to which they cannot reply, as happened on the Tugela? If heavy pieces are mobile enough to open the fight must not field artillery be reserved until its fire can be utilized in concentrating it on the decisive point of attack. We will find again this return to the idea of reserve artillery in the conclusions of Captain Gilbert, but in a much larger sense indeed. In any case the frequent employment of heavy pieces in Africa opens new horizons.

Our observer takes up also the much discussed question of the artillery duel. The theorists, he says, have attributed to it a predominant and decisive rôle in the fight. It is on the favorable issue of this duel that they make the possibility of passing to the attack or the counter-attack of infantry depend. From it they expect the success of the day. They have forgotten one very simple fact, however; even if one of the parties desires to engage in this duel, the adversary, if he does not wish to, will be able often, thanks to smokeless powder and long ranges, to refuse it. The artillery duel has never had decisive results in the South African war, because it has never really taken place. "The Boer artillery was too much outnumbered to accept it, and thanks to its skill in finding cover, favored by smokeless powder, it often succeeded in maintaining itself. Its pieces were rarely silenced. When any of them were discovered and came under fire, they were moved, and re-entered the fight behind some other emplacement prepared in advance. This was the game played at Colenso, Spion Kop, Breakfontein and Vaal Krantz.*

In the battle of the future, if the artillery knows how to mask itself, it will not be seen. Upon what will that of the attack fire? It might, utilizing cover like the defense, seek to destroy the guns of the defense one by one as it perceived them. To avoid this successive destruction, the defense might find itself obliged to open fire all along the line and reveal its position. However, on the Tugela, the bombardments of the reconnoitering force never provoked a reply; they fired at hazard because they saw nothing. It would be premature to say that the artillery duel is dead, but it will not survive in the form in which, until now, we have generally pictured it.

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* The difference of opinion on this point which we will see later on expressed by the German observer, seems assignable to the feeble resistance of the Boer artillery in the more open terrain of Orange.

If in this particular case, we are able to declare a change in the tactics of artillery, on the other hand we may affirm that nothing has happened to invalidate the principle of concentration of fire. This principle, from which Napoleon drew remarkable results at Friedland by the aid of his massed batteries, has always remained fruitful since then. The Germans made constant use of it in 1870. If the experience in Africa has proved the justness of the principle, it has shown the impossibility which one may often have of applying it. It is advantageous whenever one has a target visible and of some importance. Targets of this character the English expected on arrival in Africa. But how concentrate one's fire when one sees nothing? It had not been foreseen that the invisibility of the enemy would often render the application of this principle impossible for the artillery. This was the case at Colenso, at Spion Kop, and Vaal Krantz. However if at Spion Kop, the massed English artillery could not act, the Boer pieces, although scattered, knew enough to concentrate their fire upon the plateau so dearly disputed, and realized all that one could expect from this fruitful principle.

V. OBSERVATIONS OF A GERMAN OFFICER IN THE SERVICE OF THE BOERS.

The service of the piece by the Boers was skillful and rapid, the reconnaissance of the target easy, estimation of distance as well as observation of fire, correct, but the courage to resist to the last man was lacking. In spite of discipline superior to that of the commandos, fire was stopped and they put themselves under cover when losses commenced. The actions began generally with an artillery duel. Due to the great numerical superiority of the English, it was terminated most often by the silence of the Boer artlllery. The latter would not appear again, although that would often have been easy. The English artillery fire was then turned on the Boer riflemen in order to sustain the infantry attack. Cases occured however of a small number of Boer pieces being able to maintain their position, which shows the difficulty of silencing the fire of a hostile artillery even very inferior in numbers, when it is well placed. The battle of Dewettsdort gives us an example of this kind. Three Krupp pieces of 7.5 cm. and a Maxim-Nordenfelt, placed at intervals of 50 to 200 paces, protected behind rocks, sustained the struggle for half a day against 18 English guns at 2600 to 3000 m., the latter in the open and plainly visible. Many of these were momentarily put out of action. The arrival of 12 additional guns then quickly terminated the struggle. The Maxim-Nordenfeldt alone remained still for a time under a formidable fire, thanks to its shield ; but as it happened, on changing position to place itself more in the open, it was also obliged to abandon the game. A half only of those who had been at this piece were hit. The shield was covered with the marks of shrapnel balls. This resistance of a small number of pieces was facilitated by the defects of the English fire. The latter opened fire without knowing thoroughly where the target was, and distributed it over a great surface. To a few shots well regulated, succeeded a great number too short or much too long, and that even in cases when the Boer artillery was not well masked. This poor fire action must arise from one of the following causes: Absence of exact determination of the emplacement of the targets, poor observation, poor action of the fuzes, or defective service. Perhaps field-glasses of insufficient power may have counted for something. The importance of the quality of the latter has been especially emphasized.

How did the English shrapnel behave? A part of its balls remained in the envelope after the burst. The angle of dispersion of the sheaf was so small that the width of the dangerous space did not exceed 4 to 5 m. Under these conditions the number of hits on lines of skirmishers, not very dense, could not be very great. The dangerous space scarcely extended much more in depth: at 80 m. from the point of burst, wounds were rarely serious.

"The Maxim-Nordenfelts made a remarkable showing ; even beyond 3000 m. some of them sustained the struggle against three, four, and even six field pieces. At the battle of Boshrand, I myself fought with one of these pieces, well covered it is true, during a whole day against four English pieces. Some of the latter were indeed reduced temporarily to silence, without our having suffered the least damage. Against cavalry they showed themselves superior to every other piece. At Thabanchu, two regiments of lancers were thrown in confusion in a very short time by two Maxim-Nordenfelts. The uninterrupted series of points of burst on the ground permits readily following up a rapidly moving target; which cannot be done by a field piece using shrapnel and a much less rapid fire. I have gained the impression that the Maxim-Nordenfelt is a formidable weapon".

This opinion is, however, strongly controverted. I refer readers who may be interested to an article in the Militärische Blatter. It recites some opinions favorable to this arm, and others, more numerous, of an unfavorable nature.

Whatever may be the value of this arm, it has interested our observer from another point of view, that of its steel shields. This was the only piece which was furnished with them. He considers their advantage so great that he desires their introduction in Germany. They afforded good protection against shrapnel and musket balls, and permitted a better and more tranquil service. The shield has two inconveniences: It increases the weight by 50 to 60 kg.; it renders the position more visible. The author does not hesitate to consider these disadvantages inferior to the advantages which it assures. Morever, by choosing a suitable color for the shields, their visibility will be greatly diminished.

The English had no shields. Captain Holmes Wilson has not expressed an opinion concerning them. He limits himself to a questioning and rather doubtful attitude. He cites an English captain who carried sacks with him and filled them with sand at the moment of taking a position, to afford a protection in front of his pieces.

After these observations on the material, let us turn to those of our observer on its employment. In estimating the effect of the English fire, he has been struck with its great superiority when it was concentrated and not simply frontal. The advantage of obtaining cross fire is so great, that one must neglect nothing to secure the benefits of it. It may be attained much better by disposing the artillery in groups well spaced, rather than massing it in a single place from which it can only fire in one direction. We need not renounce the advantage of this disposition permitting concentration of fire, even if it is prejudicial to unity of direction.

Here is an example: In the battle of Donkeshock an English brigade with some batteries deployed on a plateau 4000 m. wide by 6000 m. deep, about 3000 to 3500 m. from the Boers, who had placed seven pieces on one front. Success seemed to be favoring the attack, but the aspect changed when four Boer pieces took a position on the flank. The lines of English skirmishers and their reserves began to waver under the cross fire, and their forward movement was suspended. The artillery was obliged to move to the rear, soon followed by the infantry, which executed the movement while suffering sensible losses.

A counter-attack at this moment would have had great success. The fight took place at such ranges that the infantry rifle did not play a great part; the scene shifted as soon as the artillery commenced to act in two groups with cross fire. If it is often possible to advance while protecting ourselves from one direction, it is rare that one can do so protected from two directions at the same time; this is why a cross fire is so efficacious.

Against lines of skirmishers protected by works the English often employed the lyddite shells from their navy guns or field howitzers. These shells all had percussion fuzes. To obtain a favorable effect it was necessary to maintain an accurate fire and to spend, besides, a large quantity of ammunition on a single point. We have already seen how little the English realized these conditions, which explains the small effect produced by this kind of fire. Moreover, even on bursting near by, these projectiles did not always do harm. The author saw men whose clothing was ignited by lyddite, come out of the affair with light skin burns. He saw one single shell produce a frightful effect by bursting in the midst of a crowded group of horses and their drivers.

The English guns did less harm to the Boer infantry than to the artillery, because the cannoneers of the latter could take shelter less well individually. At the sight of each hostile gun fire the men stooped down, only to rise again for each lull. "It is certain that our losses would have been more considerable if we had seen less well the hostile gun fires; because we would have been less able to avoid them." This observation is interesting; it shows how the use of cover gives, besides the advantage of diminishing our own losses, that of increasing the loss of the adversary by preventing him from sheltering himself at each gun fire.

We cannot follow the author in his interesting observations on the tactics of infantry; that would be going beyond the limits of this article. We shall limit ourselves to citing certain remarks relating to the common action of the two sister arms.

"It may happen to the infantry to be obliged to attack under a fire of infantry and artillery without being itself supported by its own artillery, and of being able readily to carry off the victory. But for that purpose it must fire and take cover from the beginning; this is the indispensable rule for both arms, especially the infantry, and before which the necessary time and space for its application become factors of an entirely secondary importance."

"However efficacious shrapnel may be against objects in the open, all that it can do against objects under cover is to prevent them from showing themselves in order to fire, and thus facilitate the advance of the infantry. It ought to sustain the latter up to within a very short distance of the enemy, for the last approach of 100 m. may still suffice for a defender even very inferior in numbers, but remaining intact, to decimate the attack by the fire of its rifles. To cover this last distance, the infantry will have to count only on itself.

This was not the English proceeding; in the infantry attack, the artillery ceased its fire much too quickly. On the contrary, when the Boers pushed forward, their artillery supported them by fire even up to 150 m. of the enemy. The shrapnel burst over our heads without touching us. I believe that we would have preferred even to receive some wounds from that source rather than do without their support."

"One learns readily enough to find shelter in the terrain from small arm fire, but with much greater difficulty from shrapnel fire; I remain convinced that a frontal attack in the open is as impossible against artillery as it is against infantry. Even at great distances, an advance of a few hundred metres under shrapnel fire suffices to decimate an organization or force it to retire. Here is the method the Boer infantry followed when it advanced under artillery fire: as soon as a projectile burst at a fair distance in front of a group, the latter ran immediately to the front to get out of the dangerous zone."

These are, finally, the conclusions of the author:

"For the future battles of a European war, the South African war gives no definite lessons. The numbers on one side, the material and its utilization on the other were insufficient. Since in many cases the English, with a triple or quadruple superiority, have had great difficulty in silencing the hostile artillery, we may deduce that in the case of two artilleries of nearly equal strength, one will have much difficulty in gaining a complete ascendancy over the other.

The true lesson of the campaign for artillery is the following: It must support the attack of the infantry by its fire, but it must not advance in the open under the enemy's fire.

VI. OBSERVATIONS OF CAPTAIN GILBERT.

In his conclusions Captain Gilbert begins by pointing out the danger of premature generalizations. In basing conclusions on certain facts of this war, we risk committing great errors. It is easy to produce examples of this. In a discussion in the French Senate on the abandonment of certain fortresses, the conclusion has been ventured, based on the resistance of Ladysmith, Mafeking and Kimberly, of the failure of the most modern artillery against entrenched camps of a certain importance. Yet, against these three fortified places, of which two had perimeters of 20 kilometres, the attack utilized for heavy calibers only four pieces of 15 cm. Can one properly condemn a material, when the task imposed upon it is entirely disproportionate to its effective strength ?

Another example which we must reproduce textually: "After the checks on the Tugela and the Modder, there were writers who condemned absolutely all frontal attacks, proclaiming as invincible the defensive sustained by skillful riflemen ; and concluding that, though leading to no decision, the defensive was in future the only tactics possible."

"The English, in spite of their enormous numerical superiority had seen their assaults pushed back. This was enough to pronounce a judgment without appeal ; the inquiry was not even made if the assaults were delivered in accordance with proper methods."

"And as the English artillery, in particular, was ten times stronger than that of the federals, as it had done all the firing in the beginning, had continued to do so, and lavished tons of ammunition without obtaining appreciable results, people were led to declare the futility of that great offensive agent, the gun and its shrapnel ; they considered as henceforth inefficacious the preparation of the attack by guns, which amounts almost to denying all chances of success to the attack."

"The truth is that the English artillery, well served, well horsed, excellently maneuvered, was employed according to the most detestable methods. Results were expected from it which it has never given, and hence, its failure should not surprise us.

"They caressed at first that chimera of reconnaissance by artillery fire, which was hatched across the Rhine, but of which our neighbors have promptly disabused themselves.

"In the plans of engagements of Sir R. Buller and Lord Methuen. we have already pointed out the complete absence of advance guard action. The hostile position was before them with all its mysteries. They searched it with their shells, hoping to get some maladroit reply which would have disclosed the dispositions of the defender. The latter, better advised, remained quietly under cover, and the powder was burned in pure waste.

"None the less they passed on to the bombardment of these undetermined positions. The artillery duel being suppressed, and for cause, they proceeded to the preparation of the final attack. But what was their idea of this preparation, and the relation of these two phases? For 24 hours at Vaal Krantz; for 36 hours at Magersfontein, they hurled against a line of kopjes the fire of 50 or 100 guns; they emptied their caissons. Then silence fell over the whole line; the artillery ceased its fire, and infantry, cavalry, artillery threw themselves forward offensively. There was complete disjunction between these two acts, the preparation and the assault; sometimes there was even quite a delay between the two.

"During the storm of this pseudo-preparation, the Boers kept themselves in their trenches; they did not have to raise their heads above their sand bags to watch over and fire upon a terrain on which the enemy had not arrived. The cannonade having ended, at the moment when the English columns much too dense appeared offensively, the defenders lined the parapets and fired on them as at target practice. Up to that time they had had but insignificant losses.

"It is, as a matter of fact, an elementary notion that field artillery acts only against unmasked objects. To oblige the defender to unmask himself, the infantry must threaten him from the outset. The artillery combines its rafales with the rushes of the infantry; it must, as General Langlois* has fully shown, continue its fire over their heads up to within 300 m. of the objective. That is the co-operation of the three arms; it is the fruitful law which alone enables the offensive gradually to lower the mask of the defender in order to strike him in the face.

"This law was disregarded by the English, as it was by the Russians at Plevna. In both cases the isolated cannonade remained sterile. Must we deduce from this the inefficiency of artillery?"

On reading these lines, we cannot avoid recurring to the description the author has given beforehand of the battle of Colenso. It deserves to be read. It is the most characteristic example of the methods of the beginning of the campaign. We learn how in the attack without definite plans, each brigade of infantry, each group of artillery marched in so many distinct columns, operating each on its own account; and what result is arrived at with a disposition which does not assure the co-operation of the several arms. We learn how the artillery of Colonel

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* L'artillerie de campagne en liason avec les autres armes, by Colonel Langlois, Librairie Baudoin, Paris 1892.

Long, two batteries and six navy guns, advanced alone in front of a brigade of infantry to within 600 m. of the underbrush which bordered the Tugela, and 1100 m. of Fort Wylie which it had for its objective ; and how at this distance, much too close, it was reduced to silence ; how finally by this isolated action, and the subsequent lack of sufficient action on the part of the infantry, this battle terminated with the loss of the guns.

But let us return to Captain Gilbert's chapter of conclusions. After having shown the violation by the English of the law stated by General Langlois, the author shows how this law has been established in the work already cited and how its rôle is destined to be still further enlarged with rapid-fire artillery. Without being able to follow this whole study, let us indicate the logical sequence of ideas. Making first a comparative study of the materials which have succeeded one another since 1870, the General finally advances the following propositions concerning the employment of rapid-fire field artillery.

1. To open fire at a decisive range (3000 m.).
2. To fire with all rapidity.
3. In order to avoid this overwhelming fire, to take advantage of cover.
4. For the same reason, to decline priority in opening fire.
5. To put in line the least number of guns which will surely produce the desired effect, both so as to display as little of our strength as possible, and to secure afterwards for our artillery the most advantageous situation.

This is the principle of economy of forces, which the new French regulations applies, in creating the term and the notion of batteries in position of observation (batteries en position de surveillance).

This last rule implies a change from the principles of 1870. We no longer seek to push into action at the moment when the mass of batteries of the main body has joined the batteries of the advance guard ; we wait until the enemy, unmasking superior forces, brings on the general artillery action.

When, in the time of Napoleon, with an effective range of 700 to 800 m., fire was opened at 500 m., every battery engaged was a battery expended. Hence the necessity of batteries kept in reserve. With the artillery of 1866 and of 1870 and effective ranges of 2500 m., results at this distance beyond the range of small arms, still left the batteries at the general's disposal. The artillery remained available ; we had the privilege of employing all of it from the beginning. With artillery provided with shrapnel and opening fire at 3000 m., batteries which have the worst of it in a struggle in the open against hostile batteries, will be immobilized by a small number of pieces and will not be able to limber up. Artillery with shrapnel ceases then to remain available once engaged. General Langlois was alone in discerning this fact in 1892. Hence he has only to emphasize his views when dealing with rapid-fire artillery. Thus :

In a fight between two batteries of the old bronze material, if one succeeded first in enclosing the other in a rectangle of 100 m. by 250 m. deep, ten or fifteen minutes of distributed and sustained fire sufficed to put out of action half of the unprotected personnel. But with the rapid-fire gun, all the personnel of the gun detachment can find shelter behind the shields, and may suspend the action. As the adversary cannot fire indefinitely, the side which had been worsted may profit by a lull to reopen its fire. The initial struggle from cover to cover leads then, at most, to silencing momentarily one of the two adversaries. The artillery duel will no longer afford a definite solution, as it did between batteries using shrapnel without shields. It leads to the gradual wearing away of the two contestants.

But if the infantry takes a hand, a new factor presents itself; the artillery will be obliged to advance to the military crest. Unmasked, the batteries will be completely immobilized or destroyed. So skill may consist in forcing the adversary to unmask himself, while remaining sheltered yourself. To obtain this result it will be necessary to push your infantry to the front. It is by the combined and intimately associated working of the two arms that one is absolved from useless and resultless cannonades.

This is the principle of the co-operation of the three arms, unheeded by the English. The artillery must by its fire force the adversary to shelter himself, in order to facilitate the attack of its own infantry. The defense will be menaced only at the moment when it unmasks itself to fire. This moment is short and the rapid-fire gun will take advantage of it better than the old material.

Returning then to the examination of the events of the Transvaal, the author notes the absence of shrapnel effect against troops under shelter and likewise its complete insufficiency against the shelter itself. He recalls how General Langlois insisted on this very important point, the consequence of which appeared to him to be that strong localities with lines of trenches would afford a very good point of support susceptible of a long resistance. The General concluded :

"Field artillery ought not to attempt the destruction of these points of support, walls, localities, shelter trenches, field works; it ought to aim at the defenders".

But how? Describing the occupation of a position put in a state of defense, where the troops remained hidden in the trenches, the supports and reserves well sheltered in rear, the General showed that the fire could have no effect.

"Any energetic fire at this time would be wrong". And he gave as an example the attacks attempted in 1870 against the line of investment of Paris:

"The preparation by the artillery consisted in raining projectiles on the points of support of the line, generally villages, for a considerable time before advancing the columns of infantry: *the fire ceased when the attack moved forward.* This mode of preparation always had for a result bringing the infantry against an unweakened defense, leading to a repulse or a success too dearly paid for".

Captain Gilbert adds:

"Does it not seem in reading these lines, that they were written for Generals Buller and Methuen? Is it not the history of their long and sterile cannonades, commenced the evening before or two evenings before the action; lasting 24 or 48 hours; then followed by a delay of several hours? Is it not the history of Magersfontein, of Venters-Spruit, of Vaal-Krantz? The English would certainly have been greatly benefitted by studying the solution proposed by General Langlois; that is to say, the intervention of the assaulting infantry, the co-operation of the two arms in the attack".

As soon as the assailant arrives at 1200 or 1500 m., the defense will be obliged to line the parapets, and in order to fire it must unmask itself and become vulnerable. It can all then be summed up in this axiom.

"The preparation by the artillery must take place during the actual advance of the infantry under the fire of the enemy's rifles; it must be violent. The action of the infantry must follow immediately that of the artillery".

Is this not precisely the principal conclusion from the campaign, which we have seen offered by the German officer who took part in it. Without having developed the subject so extensively, he pushes the application of this axiom to the limit, since he is of the opinion that the artillery must sustain its infantry up to 100 m. from the enemy, even at the risk of inflicting some losses upon it, so important is the support.

Thus the shrapnel, very effective against unprotected targets, has shown itself harmless against shelter.

To remedy these imperfections, explosive shell were introduced, which were expected to replace shrapnel successfully in this last case. It was believed that nothing could resist them. But the expectations of their effect have not been fulfilled, either against obstacles, or against troops under cover. General Langlois wrote: "To dream of the destruction of the border of Fröschwiller or of Saint-Privat, was pure folly ; all the munitions of an army corps transformed into elongated shells, would not have sufficed to demolish one of these villages".

The example of Modder River, bombarded an entire day by Lord Methuen's shells and all of whose houses were still standing in the evening, confirms this assertion. Though inhabited places preserve their value even against torpedo shell, the true objective of artillery continues to be not the cover but the defender placed behind this cover. But there again we meet with the same disappointment. The fragments of the projectiles are so small that they lose their force at 10 or 15 m. from the point of explosion. And this was an especial defect with these projectiles. The only superiority that can be given them is their very great effect when they burst in an enclosed space. The facts of the war confirm these statements. At first the high explosives terrified the Republicans ; but as soon as the first astonishment was passed, they became accustomed to them because they saw that lyddite did not produce great destruction. Here is a striking case. A Boer, between whose legs a lyddite shell burst, was thrown into the air and fell on a sack of flour without suffering the least injury. On the other hand, here are two cases of considerable effect in a closed place. A melinite shell bursting in an officer's mess at Ladysmith, did great havoc ; and likewise a lyddite shell, bursting in a room at Modder River, killed the seven Burghers who were there.

If General Langlois attributed to high explosives a very secondary value, quite different was his appreciation of smokeless powder. It modifies considerably if not the battle, at least its first engagements, since it increases the difficulty of reconnaissances and leads armies to become engaged under unknown conditions. Each arm taken by itself is powerless to solve the enigma. Reconnaissance by the artillery has given its negative proofs at Colenso, Modder River and Magersfontein, and in almost all the battles of Natal and Orange. A few rifle shots will suffice to stop cavalry, which was likewise the experience in

Africa. As for the infantry, a few isolated men will accomplish nothing; and as soon as a fairly important force is employed, we will see them put to the alternatives of going to a certain death, or recoiling under a murderous fire, or awaiting the support of artillery. It is then the co-operation of the three arms which is necessitated; and quite naturally it will be the advance guard consisting of all three arms, which will be the true instrument of reconnaissance.

As to this gaining of contact being rendered more difficult for the assailant by reason of smokeless powder, General Langlois draws two conceptions: The game of *advanced lines or screens of artillery* on the tactical checker-board, and the game of *covering detachments* on the strategic checker-board. To covering detachments, the offensive will oppose *advance-guards of exploration;* to advanced lines, *advance-guards reinforced* by the mass of artillery. Advance-guards of exploration and reinforced advance-guards are only modes of application of the same principle, that of action from deep formations (en profondeur). Before this principle, the old idea of the line of defense is obliterated.

We cannot follow the entire development of this new idea, as it oversteps the limit of our subject. Let it suffice to say that the author, examining in its light the events of the Transvaal, notes that we find on the part of the Boers a certain notion of gaining several points of contact; and of the employment of covering detachments or advanced lines. For example, in the battles which Cronje fought before his position of Magersfontein. On the other hand, the English with their premature deployment of all their forces on the whole front, ignored completely this principle of action from deep formations. Enlightened upon the difficulties of gaining several points of contact, they sought to avoid the difficulty by covering their approach under the darkness of night. This is an expedient which may be suitable for the storming of a post; we know what resulted from it at Stormberg and Magersfontein.

Captain Gilbert's book stops here. Some lines, added after his notes, give his conclusions: "For the war of the future, the lesson to learn from the present war is this:

"The difficulties of reconnaissances and of gaining contact, resulting from the considerable progress realized in armament, show the necessity of advance-guards and of covering detachments, and justify the employment of advanced lines of artillery. The struggle on the field of battle must be carried on from deep formations, if one wishes to derive benefits from reserves.

"The same motives lead equally to increasing the front of the defensive deployment; the defensive front of an army corps may, at need, have an extent of 8 to 9 km., to the great advantage of the principle of economy of fire, and to facilitate the use of the reserves. The latter may then act either *en profondeur*, or at the chosen point of the front, or even preferably in the form of groups detached on one wing or on both wings.

"An army of four corps, occupying thus 20 km. would have two of its corps at the center for the frontal fight, those of the wings reserved for maneuver.

"Finally I have reserved intentionally the lesson which I regard as essential—".*

As we have seen, Captain Gilbert shows himself a great partisan of the ideas of General Langlois. We have no intention of discussing them since this article is purely objective. We have referred to them along with the observations of Captain Gilbert, because, in his work, the observations constantly proceeded from these same ideas. It is interesting to note the part they have played in the elaboration of the new regulations of the French rapid-fire field artillery.

Thus the notion of batteries in position of observation flows from the principle of economy of forces. But if this point of view has prevailed, every one does not appear to be in accord as to its application. Let us point out, for example, the reserve with which Major G. Rouquerol speaks of it in his recent work; Emploi de l'artillerie de campagne à tir rapide. "It would be fatal", says he, "if we make it a general rule".

Likewise a rigorous application of the principle of action *en profondeur* to advanced lines of artillery does not meet with the unanimous acquiescence of tacticians.

Finally, if the employment of modern arms seems to permit giving a greater extension than in the past to a defensive front, ideas vary much as to the degree of the extension permitted. Thus in Germany they are contented in general to admit the more modest figure of 5 km. for the defensive front of an army corps.

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* What is the essential lesson of which Gilbert wished to speak? Death has prevented him from revealing his thought, and it does not pertain to any one to try to substitute themselves for him. All of his friends, that is to say those who had the honor of approaching "the greatest thinker of the French army", will know how to conclude. (General Bonnal's Eulogy of Captain Gilbert.)

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FIELD ARTILLERY SIDE ISSUES.

Glanders and Its Diagnosis.

BY GERALD E. GRIFFIN, VETERINARIAN, ARTILLERY CORPS.

Glanders and tetanus among horses of the army appear to be more dreaded than any other disease and less understood by officers of the mounted service.

In the army generally it is believed that the only specific for an outbreak of glanders, suspicious or otherwise, is the bullet, and so firmly has this belief taken hold that hundreds of animals in recent years have thus been sacrificed, and thousands of dollars worth of property needlessly destroyed.

It has been the experience of the writer, time and again, on arriving at the scene of a reported outbreak to have all his efforts for the first hour or so directed to preventing the further destruction of unfortunate animals and to allaying the fears of disturbed and stampeded minds, after which followed the investigation and examination of the cases, which, it must be said, in very many instances showed too plainly that some wretched mistake had been made.

A few years ago, and even now for that matter, when glanders was supposed to have made its appearance in a stable there was a hubbub reaching from the stable orderly to the post commander ; everything was to be shot down, boiled, burned, washed or steamed, and before good sense began to prevail a board of survey, having no veterinary knowledge—or if any, of a very superficial nature indeed—was appointed. Its first and last meeting was death to all suspects.

It is well to remember that on account of improved sanitary conditions, good stable management, intelligent care and more able veterinary supervision, glanders as a disease is rapidly disappearing. Or is it because we are becoming more liberal in our views, more diligent in our examinations and more intelligent in our diagnosis that we now fail to declare as glanders every unusual condition of the lymphatic system we do not thoroughly understand ?

Either glanders is not readily transmitted to man or three-fourths of the so called outbreaks of this disease have been due to erroneous diagnoses, for we have on very many occasions encountered farriers and others, the cuticle of whose hands and arms was badly fissured and showing many fresh abrasions, treating so called cases of acute glanders and yet we have failed to have heard of a single innoculation in any person thus dangerously exposed.

Contagious diseases, except in one or two instances, and glanders is not one of them, do not spread like "wildfire" among domesticated animals ; a case of glanders in its acute form may be present in a well managed stable and yet every horse therein may resist the contagion indefinitely.

We should act with the utmost caution in cases where glanders is suspected and we should make full use of the complete instruments science has placed in our hands, instruments which if properly handled point out beyond the shadow of a doubt the absence or presence of the only cause of the disease, the bacillus of glanders.

In our investigations let us conform our diagnosis as we progress, thus permitting us to rest secure in the knowledge that we have not sacrificed unnecessarily the life of one animal, valueless though it may be.

Of course it is almost needless to remark that glanders and farcy are one and the same disease, the term farcy being applied to the symptoms as they appear on the skin in the form of "buds," "buttons" or nodules.

One of the ablest veterinary authorities says, "Glanders is a contagious, constitutional disease of the horse family and is readily communicable to man, sheep, dogs, etc., but not to cattle. It makes itself manifest by the formation of tubercles which degenerate into ulcers or chancres from which exude a discharge of a peculiar character.

Its period of incubation is variable and uncertain and it runs a variable course until it produces the death of the animal afflicted, the acute form being most rapidly fatal."

The cause of the disease is the introduction of the glanders bacilli into the system and their propagation therein. No matter in what form the disease may manifest itself, acute chronic or latent, it is contagious if the subject receiving the innoculation is sufficiently non-resisting.

The bacilli of glanders were discovered by Loffler in 1882. As seen through a microscope they appear as small, slender rods the ends of which are rounded, they are not mobile but possess, however, great molecular vibration ; they very rarely appear in masses but are discovered usually singly ; many of these rods show spores or seeds which appear as round, granular bodies, surrounded by a very resisting membrane, these contain the young bacilli; to the resisting nature of this investing membrane of the spore or seed and the difficulty experienced in reaching their contents with disinfectants the contagion of glanders owes its tenacity, which may continue from sixty to ninety days in an infected stable, vacated, well ventilated and thoroughly disinfected.

The bacilli of glanders can be propagated artificially in the laboratory by innoculating a suitable media such as agar-agar, gelatine, potato, etc., placing in an incubator at a given temperature for a period of several days when they begin to multiply rapidly; from the product of these bacilli the much advertised mallein is obtained.

The bacilli cannot readily be observed through the microscope without a special preparation or staining. The specimen about to be examined is stained, with carbol-blue for instance, then a decolorizing solution of muriatic acid is added; this decolorizes the specimen but leaves the bacilli stained, it is then comparitively easy to pick out the rod-shaped bodies.

Mallein.—This is a liquid substance procured from large quantities of the glanders bacilli artificially propagated. The product of the bacilli is reduced by evaporation and put through a filter which has the property of retaining the bacilli themselves but permitting their liquid products to pass through. This filtrate is diluted and on the addition of an anti-ferment to prevent decomposition it is ready, roughly speaking, for use in carefully estimated doses.

It is claimed that if a certain quantity of mallein be injected hypodermically into the healthy animal it will have little or no effect upon his temperature or at the point of injection; that is, the temperature will remain about normal, say one hundred degrees F., or it may reach as high as one hundred and two degrees; while at the seat of injection there may be a slight swelling which will disappear in a short time. But if the injection be made into an animal afflicted with glanders, chronic or latent, (of course in the acute form we would have a high temperature and therefore no reaction, or if one was obtained it would be masked by the febrile condition of the subject) it will cause a very pronounced thermal reaction, the temperature going often as high as five degrees above the normal,—which roughly may be called one hundred degrees F. in the mature horse,—while at the seat of injection there will be a considerable swelling showing sensitiviness on pressure and often developing an abscess which remains for many days.

The question very naturally presents itself: Why does the injection of mallein into the healthy horse produce no rise in temperature while in the glandered horse it does? The writer has been unable to learn of any good reason for this, the usual explanation being that the injection of the mallein stirs the bacilli to greater activity. Our own theory is that in a latent or chronic case of glanders the resisting elements of the system retard the propagation of the bacilli to any great extent, thus holding them to a minimum in numbers. These do not secrete sufficient of their products to have its effect manifested on the heart until from some cause the vitality of the animal is lowered when, the resisting powers being weakened, the bacilli immediately begin to multiply and secrete or excrete. When mallein is injected into a case of this kind it is sufficiently irritating, in combination with the small quantity already present in the blood from the infected area, to act upon the heart and cause a temporary but mild increase in the temperature.

Before testing a suspect with mallein it must be established that his health is nearly normal, when a series of temperature readings extending over a period of forty-eight hours should be taken and compared with those from a control or check animal known to be free from glanders, meantime using absolute cleanliness and antiscepsis in the manipulation of the thermometer. The normal condition of the animal being established (the usual precautions as to cleanliness, etc., in connection with the hypodermic syringe and seat of injection being observed) the suspect and control cases are both injected with a given quantity of the mallein, (preferably on the side of the neck as any swelling there can be more readily observed) after which another series of temperature readings and comparisons extending over a period of from eighteen to twenty-four hours are taken, also observations on any local swelling that may occur, appetite, restlessness. excretion of urine, etc. The reaction is supposed to reach its maximum in from eighteen to twenty four hours after injection and then gradually disappear.

If one has faith in this test conclusions should be about as follows. Well marked thermal and local reactions ; kill the subject, he is afflicted with glanders.

No reaction or a very slight one : no glanders.

Unless one has perfect faith it would be advisable in all cases to make a thorough post mortem examination as in the first place it would demonstrate the presence or absence of the pathological lesions and again it would relieve one's mind from after doubting, for who of us has faith sufficient to believe implicitly without ocular demonstration?

As to the clinical symptoms of glanders on which so many pin their faith and on which so many mistakes are made; is it necessary to enumerate them here?

The tubercles or nodes about the size of number one shot, seen on the mucous membrane of the nose, which soon soften and turn yellow followed by a breaking down into small ulcers or chancres showing a dirty grey bottom and ragged edges, from which exude a "viscous oily discharge", to which adhere seeds, dust, bits of hay, etc. The hard swelling high up between the lower jaws and firmly adherent to the base of the tongue and feeling like a small bunch of hard berries. The swelling of the legs. The peculiar dry chronic cough and in the farcy form the "buttons," "buds" or nodules on the inside of the thighs and along the side of the neck, lower parts of the shoulders and the under surface of the abdomen. The occasional bleeding from the nose, and lastly, the more or less elevation of temperature,—these are all too well known to the glanders sharp to need further description here, but unfortunately almost all of these clinical symptoms appear in part in other diseases of the horse, even to excoriations on the mucous membrane of the nostril, the "bud" formation along the course of the lymphatics, the swelling of the legs, cough, etc., thus complicating otherwise plain sailing. He would be an able or a bold pathologist indeed who on examining an animal on clinical signs alone would say, "this is an undoubted case of glanders," and yet how often has it been done and how many lives have been sacrificed on such an unthinking declaration.

The post mortem lesions in a case of acute or chronic glanders are generally found along the course of the air passages, septum of the nose, larynx, lungs, etc., and may also be found in the liver, spleen and kidneys as well as in the various lymphatic glands, especially those of the neck and thorax. These lesions appear in the form of tubercles—small, hard, indurated nodules; when these have existed for some time we may find a deposit of lime salts in them.

These hard tubercles retain the bacilli as can readily be demonstrated under the microscope.

"The blood of an animal suffering from chronic glanders is not virulent and is unaltered, but during the attack of acute glanders, while the animal has fever, the blood becomes virulent and remains so for many days".

The mallein test, it must be said, after fair and unprejudiced trial on hundreds of diseased and healthy horses covering an experience of many years, has not proven itself reliable in the hands of the writer, as it has very often given a thermic and local reaction the significance of which could not be demonstrated by the subsequent post mortem and microscopical examinations.

It is believed that the mallein furnished by the Bureau of Animal Industry is the equal of any manufactured, yet the people of the Pasteur laboratories (who, by the way, sell their mallein) claim that of the Bureau to be very unreliable, to say the least.

Only recently we learned that glanders have been declared in a certain stable and that three cases had been already destroyed on clinical symptoms. As this stable was close to those of the artillery battalion serving at this post we became considerably alarmed and interested enough to give the mallein used a test among the horses of the battalion and with alarming indications. In the meantime the destruction of horses in the stable mentioned was being carried out on the results of the test until as many as fifteen were thus disposed of ; finally on request, a post mortem examination of one of the supposedly worst cases was held but no lesions of glanders could be discovered, neither could any indications of glanders be demonstrated on a careful microscopical and laboratory examination. Finally the mallein testing was abandoned, new horses introduced and up to the present (nine months) nothing resembling the disease has appeared, although the quarantine established was at no time effective and the sanitary steps taken were of a very perfunctory character.

The mallein test is not sufficiently reliable to permit it to stand unquestioned ; still, want of a better general method may be an excuse for using it all, but its indications should be proven by a thorough post mortem examination in every case and a second animal should not be destroyed until it has been proven that this disease is present ; it often having been brought home to us that the ordinary methods of investigation and diagnosis in this disease leave us very much in the dark.

In an outbreak or reported outbreak of glanders attention is first attracted to some animal discharging from the nostril, on inspection a sore or sores may be detected on the mucous membrane of the nose, swelling under the jaw, etc., when without more ado some one unthinkingly suggests glanders, the stampede takes place and we know the rest. In some instances the suspected animal may be isolated for a few days but as the nasal discharge and sores have had their effect on the minds of those more directly interested, the animal is invariably destroyed on the grounds that it is better to be sure than sorry ; there is little mercy shown to any suspects that may appear subsequently.

To make a diagnosis of glanders in a stable and at the same time place this diagnosis beyond the shadow of a doubt ought to be the aim of those interested when a report of the appearance of this disease is spread. It is believed that if the following method is pursued it will be instrumental in saving from destruction hundreds of serviceable horses and at the same time relieve the tension that always exists when the presence of this disease is suspected.

Learn the history of the animal as far back as possible, also the history of the other horses in the organization.

Inquire as to the prevalence of glanders among civilian horses in the neighborhood, remembering that the incubative period of this disease is very uncertain.

Isolate the suspected case at once and examine the symptoms presented in a painstaking exhaustive manner.

Prepare several microscopic slides, make several specimens from the nasal discharge, in the vicinity of the ulcers if any are present, and submit them to a microscopical examination ; if results are negative wait a day or two and try again.

If the health of the animal appears to be normal make the mallein test using two or more healthy control cases.

If a reaction takes place in the suspect and not in the control cases it would indicate that something serious was the matter, the suspect should then be destroyed and at the post mortem examination, held immediately, the respiratory and intestinal tract should be closely examined for pathological lesions. Make microscopical examinations of specimens of these and demonstrate the presence of the bacilli ; they must be present before a declaration of glanders should be made.

Being satisfied that glanders is present and having no clinical symptoms as a guide in the remaining animals, and having doubts as to the reliability of the mallein test, the following method presents itself in addition.

The serum from the blood of a healthy horse has no effect when added to a culture of the glanders bacilli ; while on the contrary the serum from the blood of a glandered animal, no matter how obscure or absent the clinical symptoms, has the property of agglutinating or clumping the bacilli in the culture in from one to two hours; this method may be used as a means of confirming the mallein test.

Under the microscope the bacilli of glanders in culture are well distributed over the field but when the serum from a horse infected with glanders is added in about the proportion of one of serum to three hundred of the culture, the bacilli begin to gather together in clumps and within the time mentioned will have clumped or gathered in bunches on the field of the microscope. This clumping is sufficient proof that glanders exists in the animal from which the serum was obtained ; thus all of the horses of an organization may be examined with the reasonable assurance that the presence or absence of the disease will be pointed to in each case ; still on an animal's being destroyed a thorough post mortem examination should be made and the presence of the bacilli demonstrated in each case.

A safe way for the operator to make a post mortem examination is to have a stout tripod erected, similar to those used in the slaughter of steers by small butchers, have a block and tackle attached for hoisting purposes and expose the viscera as per the method of the butcher; this reduces to a minimum the risk of cutting the hands.

When glanders has been proven to exist in an organization all infected animals should be destroyed, the building should be vacated, cleaned and thoroughly disinfected, no half hearted disinfection is permissible, the entrances to the stable should be protected by stout wire netting and chains, and doors and windows thrown open to the weather for at least three months before it is again occupied ; of course, it is needless to say that all equipment, such as harness, bridles, saddles, blankets, brushes, grooming cloths, combs, brooms, forks, buckets, feed carts, measures, drenching bottles, stable clothes, etc., should be included in the disinfection.

In conclusion consideration is asked for the following suggestions:

When an outbreak or supposed outbreak of glanders is reported as having occurred in a battery on duty in the United States, the chief of artillery should be notified by wire, when a second veterinarian of the artillery corps could be ordered to the point for consultation and investigation.

A declaration of glanders should never be made on clinical symptoms or mallein test until the presence of the bacilli is demonstrated by aid of the microscope.

At least one uninterested veterinarian should be appointed on each board of survey convened on such occasions.

A post mortem examination should be made of each animal destroyed.

The keeping of stable clothes, often reeking with dandruff, hairs, dried scabs, nasal discharge, manure, urine, etc., in the quarters of the men should be discontinued, the practice is an unsanitary one to say the least.

It may seem superfluous to many that so much should be written on such a familiar subject as glanders, but if one pauses and gives thought to the thousands of lives of horses sacrificed on suspicion of this disease alone, it is thought it will be seen that still more thorough investigation is needed; it is also believed that if this method of arriving at a diagnosis in this disease is adopted and the suggestions offered carried out, it will be the cause of reducing the number of horses yearly destroyed for glanders at least seventy per cent.

PROFESSIONAL NOTES.

Range and Drift Rulers for Mortars.

BY CAPTAIN ROBERT E. WYLLIE, ARTILLERY CORPS.

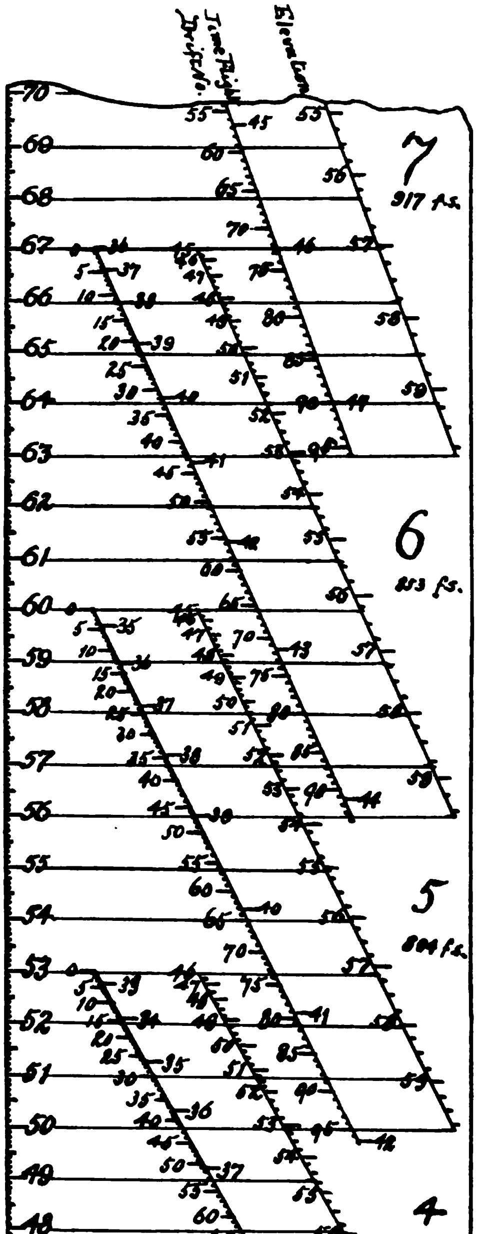
In No. 65 of the JOURNAL are two articles on this subject, one by Captain P. P. Bishop and the other by Corporal O. Van Beek. As the ruler in use by my company differs somewhat from any I have yet seen described, a description of it, together with the events leading up to its design, may be of interest.

The original article on a drift ruler, written by the late Major C. L. Best, appeared in the summer of 1902, and provided for two rulers, one the drift ruler proper and the other the range ruler, on which were placed the necessary data. A ruler was then constructed at this post, under the direction of Major Best himself, in which all the data were placed on the drift ruler, thus combining the two original rulers in one. This was used during the maneuvers of 1902. A further modification of the original plan was made in the arrangement of the column of elevations, the drift curves being graduated into degrees and subdivisions, which did away with the awkward feature of the double column arrangement of the original ruler, which feature is still retained in the rulers of Captain Bishop and Corporal Van Beek, although the former has relieved it somewhat by employing different colors for adjoining zones; but the double columns are still there.

The objection to the ruler as thus constructed lay in its narrowness from the first zone to the fifth, it did not give sufficient room for clearness in the necessary data and the ruler was moreover too weak for handling. Captain Bishop has overcome this by making his ruler one width throughout, and cutting slots for his drift curves. I worked on the same idea but found a great liability to error, due to the fact that in swinging the ruler to get the plotted position on the curve, no part of the board immediately interested is visible, except through the slot, consequently great care had to be exercised not to go beyond the point and not to mistake some other mark on the board for the one desired.

I then experimented with transparent celluloid as the material for the ruler, but found that the expansion and contraction in a piece of the necessary length was so great as to be prohibitory. Corporal Van Beek's device however, appears to solve the problem in a very satisfactory manner, so far as the drift and shape of the ruler is concerned, but the old double column arrangement for the data was retained by him.

In the ruler I have recently constructed for my company, I have incorporated Corporal Van Beek's method for drift correction, (using 100 instead of 120 divisions) and have arranged the elevations, times of flight and drift correction numbers in diagonal lines, thus each zone is separate and there is no jumping from one column to another in the same zone, with its attendant delay and liability to error; the exact method can easily be seen by an inspection of the drawing accompanying this. The zones are laid off directly on the plotting board, the overlaps being colored, which enables the prediction



Range and Drift Scale for 12-inch B. L. Mortar.

for zone to be made without bringing up the ruler—for horizontal base work I use wire threads, made of banjo " E " strings, and only bring up the ruler in order to get the data for laying the pieces. The ruler is made of zinc, painted with lythite, which is better for the purpose than any other easily procured material I have yet seen. Prediction rulers in use at this post are also made of this metal or galvanized iron, with a stud soldered on top for convenience in handling.

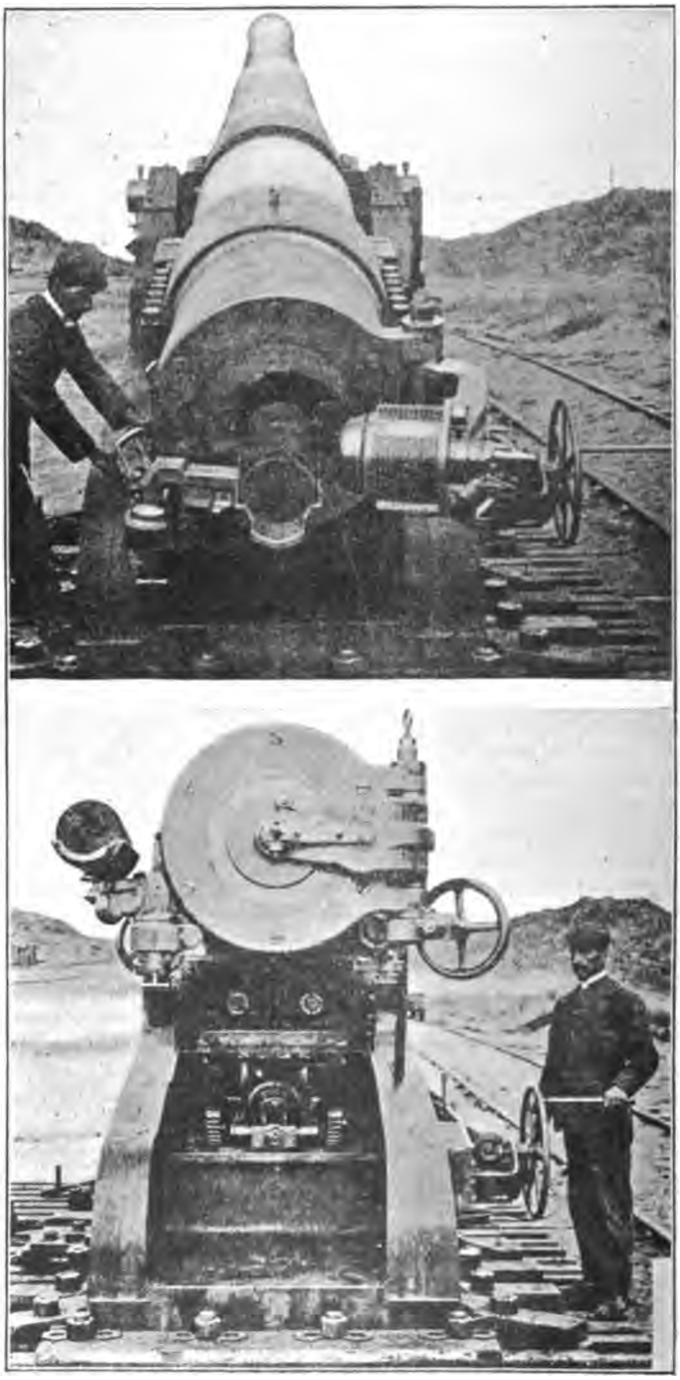
The New Vickers-Maxim 9.2-inch Wire-Wound Gun.

This weapon is a good representative of the latest improvements which have been introduced into heavy ordnance, with a view to securing at once greater range, increased penetration, and a higher rapidity of fire, without adding materially to the weight of the piece. The theory of design and methods of construction by which these results have been secured are not by any means peculiar to this piece, inasmuch as they have been followed by gun makers for many years; but the significance of this 9.2-inch gun is that in it we see what is, perhaps, the most successful combination of these qualities that has yet been attained. Although this gun weighs only 28 tons, and has a service rapidity of fire of five rounds in a minute and a half, it has a power of penetration at 3,000 yards (the minimum fighting range of to-day) approximately equal to that of the 13½-inch English gun, of more than twice the weight, of a dozen years ago.

The immediate cause of this increase in efficiency is the greater velocities that are secured with modern guns; and the increase in velocity is due to the enlargement of the powder chamber, the use of slow burning powder, and the lengthening of the bore, so as to enable the products of combustion, as they are given off by the burning powder to exert their accelerating effect upon the projectile for a longer period and with a higher average pressure. To such a successful point have these principles been carried, that the latest types of gun, such as the one herewith shown, have fully fifty per cent greater velocity than the guns of ten or fifteen years ago. The gun weighs 28 tons, has a total length of 37.2 feet, a bore of 9.2 inches, and measures 36 inches in external diameter at the breech and 18 inches at the muzzle. It fires a 380-pound projectile with a muzzle velocity of 2,900 feet per second, and a muzzle energy of 22,160 foot-tons. The penetration of wrought iron at the muzzle is 37 inches, and at the minimum fighting range of 3,000 yards its projectile striking squarely would pass through 11 inches of Krupp steel, so that the water line armor of practically every battleship afloat would be penetrable by this gun.

The piece is built by the wire-wound method. It consists of an inner tube containing the powder chamber and the rifling, over which is shrunk a heavier inclosing tube of gun steel, and upon this is wound, under very high tension, the wire upon which the gun mainly depends for its tangential strength. Over the wire is shrunk on a single heavy jacket, which extends from the breech for nearly two-thirds of the length of the gun, and a chase hoop, or tube, which extends to the muzzle, which latter is slightly swelled to a large diameter, to give the extra reinforcement needed to prevent splitting at this point.

The breech mechanism is shown very clearly in our illustrations. The whole of the breech action, namely, unscrewing the plug, withdrawing it,



9.2-IN. WIRE-WOUND GUN WITH VICKERS' LOADING TRAY.

and swinging it clear of the breech box, is accomplished by the continuous rotation of the hand wheel shown to the right of the breech. The breech plug is of the same type as that used in our navy. It is threaded in segmental portions on steps of varying radii, an arrangement which enables three-quarters of its circumference to be threaded, and to be available for meeting the longitudinal thrust on the block. The ordinary type of block has only half of its circumference threaded, so that the new type of plug may be made proportionately shorter than the old. This shortness of the plug enables it to be swung clear from the breech as soon as it is unscrewed, thus saving the time occupied in the old type of block in withdrawing the plug in line with the axis of the gun, before swinging it clear of the breech box.

Another element of interest in this gun is found in the fact that it is built upon the same principles and is of the same general efficiency as the Armstrong gun, with which nearly the whole of the Japanese navy is armed; although it should be understood that this particular caliber of gun is not used by the Japanese, whose battleships and cruisers are armed with the 12-inch, 8-inch, 6-inch and 4.7-inch Armstrong guns. The 9.2-inch gun, however, forms the primary armament of the British cruisers, and the intermediate battery of the latest types of British battleships, just as the 8-inch gun occupies the same place in the respective classes of ships of our own navy. The latest British designs carry eight of these 9.2-inch guns in four barbettes, in addition to the primary armament of four 12-inch guns---an impressive evidence of the vast increase in the offensive power of warships, due to the improvement of ordnance and the increase in displacement.

—*Scientific American*, March 26, 1904.

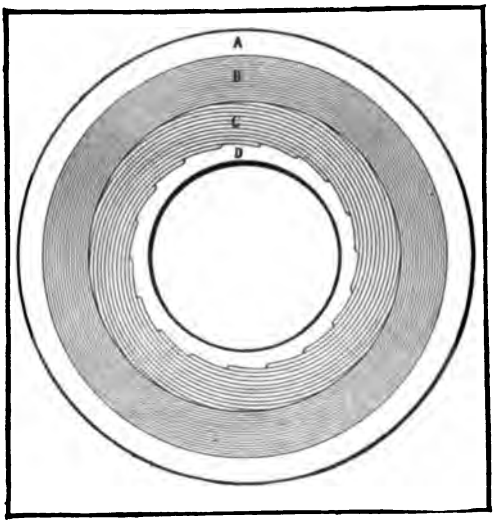
High Velocity 6-inch Wire-Wound Gun for the United States Army.

The Board of Ordnance and Fortifications of the United States army recently made an allotment of $41,000 for the construction of a 6-inch Brown wire-wound gun which, if it fulfills the requirements of the specifications on which it is built, will certainly be the most powerful piece of its weight and size in existence. The gun will shortly be tested at Sandy Hook proving ground and fired 250 rounds, with gradually increasing powder pressures, the last five rounds being fired from under 45,000 to 50,000 pounds maximum pressure in the powder chamber. The estimated service velocity of the gun is 3,541 feet per second, under a maximum powder pressure of 42,823 pounds.

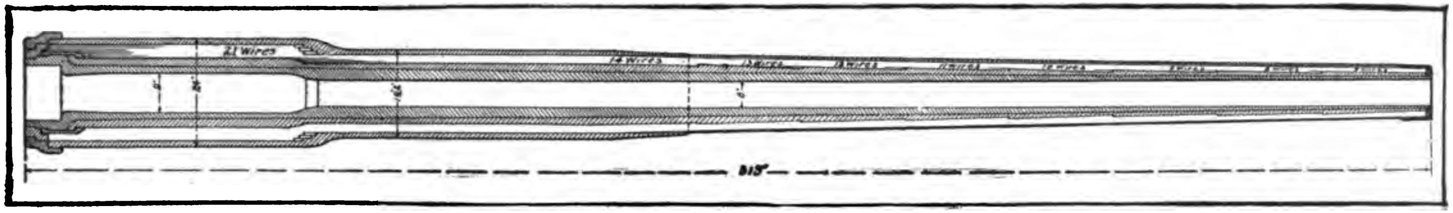
The full significance of these figures will be realized if we compare them with the ballistics of the 6-inch 50-caliber navy gun, which is designed for a muzzle velocity of 2,900 feet per second when firing a 100-pound projectile. On February 8 of the present year the Bureau of Ordnance, in consequent of recent failures of some navy guns, decided to reduce the service velocities, and an order was sent out that the 6-inch, 50-caliber navy gun was to have a service velocity of only 2,700 feet per second, which is 800 feet per second less than the service velocity designed for the new wire-wound gun under construction. As the striking energy of the shell varies as the square of the velocity, it will be seen at once how very much more efficient the new piece will be than the latest type of navy gun.

Although the wire-wound gun is but little known in the United States, the gun built by Capt. Crozier and the various Brown wire guns which have been built and tested by the army being the only guns of the wire type that have been built in this country, the wire-wound system has been adopted by the English navy and is the standard type that is built by the two great gun-making firms of Armstrong and Vickers-Maxim in England. All the large guns of the latest English warships are wire guns, as are the weapons which are doing such good service in the Japanese navy during the present war in the Far East. The system has, therefore, long ago passed beyond the experimental stage. The difference between the wire gun herewith described and the English and Japanese guns is that in the former the fundamental principles upon which wire guns are constructed have been carried further along their logical lines of development, with ballistic results that are proportionately superior.

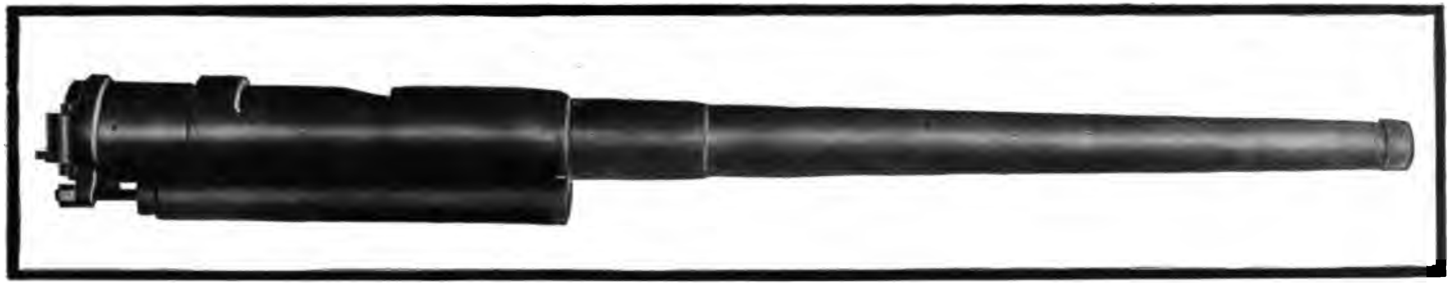
In the construction of the new 6-inch gun, the foundation consists of a forged steel lining tube with an elastic limit of 60,000 pounds and an ultimate breaking strength of 105,000 pounds to the square inch. This tube extends for the full length of the gun, which is 26 feet 1 inch in length, and it is enlarged from a diameter of 6 inches in the bore to a diameter of 9 inches in the powder chamber, which has a length of 49.3 inches and a cubical capacity of 3,120 cubic inches, which latter, it will be seen, is exceptionally large for a gun of this caliber. On this tube is assembled what is known as the segmental tube. It is formed of a series of sheets of rolled steel, 308 inches in length, 21½ inches wide at the breech, and 4½ inches wide at the muzzle of the gun, which are rolled into an involute shape and wrapped together to make up a solid tube. The sheets are first assembled on a stepped core, or former, and securely clamped. The core is then withdrawn, and a stepped lining, of the section shown in our engraving, is forced into position within the segmental tube and the clamps are firmly screwed down, one at each 6 inches of the length of the tube, which is then centered in the lathe and turned to size. A new series of clamps is then put on, and the exterior of the segmental tube is turned down into stepped frustums of cones, each step being equal to the thickness of one wire, or one-seventh of an inch. There are



Cross-Section through the Gun at the Powder Chamber.

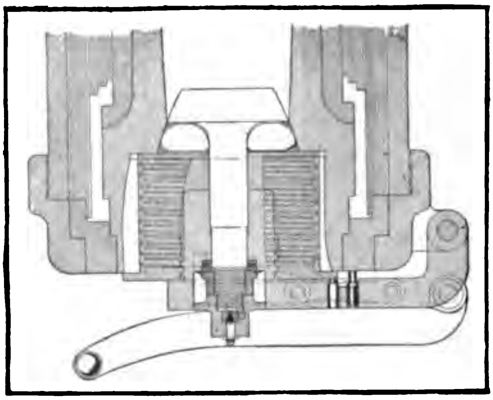


Longitudinal Section, Showing Thickness of Wire Winding.



New 50-Caliber, 6-inch, Wire-Wound Gun for the United States Army, Shortly to be Tested at Sandy Hook. Maximum Powder Pressure 42,823 Pounds. Muzzle Velocity, 3,541 Feet per Second.

seven of these steps over the bore of the gun and four steps where the powder chamber commences, one of the latter steps being the depth of one wire and three of the steps equal to the depth of two wires. Now comes the process of wire winding. One end of the wire is driven into a hole bored in the segmental tube at the first step from the powder chamber, and the wire, which is one-seventh of an inch square, is wound upon the gun under a tension of 2,500 pounds. The thickness of the winding varies from seven thicknesses, or one inch, at the muzzle to 21 thicknesses, or 3 inches, over the powder chamber. A trunnion jacket, extending from the breech to beyond the trunnions, a distance of about 12 feet, is then shrunk on with sufficient tension merely to prevent its rotation upon the segmental tube. A sheet-steel tube is also placed over the chase of the gun for the purpose of giving it a finish and protecting the wire wrapping. It should be noted that no reliance is placed upon the trunnion jacket or the chase covering, for the strength of the gun. By a study of the sectional view of the breech, it will be seen that the thrust of the breech block is taken up jointly by the lining tube, the segmental tube, and the trunnion jacket, and a very even distribution of the longitudinal stress is thereby secured. The advantage of using a segmental built-up tube to carry the tension of the wiring is that the plates being rolled down to a thickness of one-seventh of an inch, the danger of hidden flaws existing in the metal is practically eliminated; whereas, when the solid tube is used, as in the built-up guns, there is sufficient thickness of metal for such flaws to exist without being detected. Moreover, in the segmental tube, should a flaw exist and a fracture occur in any one plate, it could merely extend through the thickness of one-seventh of an inch, and would not, as in the case of a solid tube, extend radially through the whole thickness of the tube.



Longitudinal Section Through the Breech.

The unusually high velocities secured in this gun are due to the exceptionally large powder chamber. Owing to the abundant supply of gas given off by the burning powder, the pressure on the base of the shell is maintained at a high figure even to the moment that the shell leaves the muzzle, when the pressure is no less than 23,721 pounds to the square inch. In the earlier guns, the powder pressures fell rapidly toward the muzzle, and it is this high muzzle pressure that has caused the blowing off or bursting of the chase of several guns of the hooped type during the past few months. It can be seen at once that by increasing the number of windings of wire over the muzzle, this part of the gun may be made relatively just as strong and reliable as any other portion.—*Scientific American*, May 7, 1904.

Guns.

By far the most important of the new ordnance guns which is being introduced into the British navy is the 7.5-inch gun with its charge of 77¾ lbs. of cordite, projectile of 200 lbs., and muzzle velocity of 2,860 foot seconds. For the present this is relatively the most powerful gun we possess, and it cannot be matched for range, penetrative power, speed of working, facility of loading, and general all-round usefulness by the ordnance of any other nation, says The Engineer, London. The guns coming forward for proof are of 45 calibers in length; that is 337½ inches, and the mountings, although yet necessarily in an experimental stage, are of the handiest possible description, the gun and mounting being under the complete control of the gun layer, while the breech mechanism is of the simplest character.

The new 4-inch quick-firing gun, which is to replace the present description of British ordnance of that caliber, is a decided improvement on the gun now in use. With a charge of some 10 lb. of cordite it projects a shell weighing 31 lbs., with a muzzle velocity exceeding that of the present 4-inch gun by no less than 530 foot-seconds. The charge now in use for the 4-inch guns mounted afloat being 3 lbs. 9 ozs. only, and the projectile 25 lbs. in weight, this is a very valuable improvement. One remarkable feature of this design of ordnance, says The Engineer, London, is that the charge will not be inserted in a brass case, but will be made up " bare; " that is to say, in a silk-cloth bag only.

In consequence of the existing Portugese field gun being completely out of date, a commission was sent in August, 1903, to France, Germany, and England in search of a new model. According to the Portugal Militar the commission was unable to decide between a Krupp and a Canet gun, and two guns from Krupp, differing somewhat in construction, and one from Canet, are now undergoing tests at the range at Vendas Novas. The guns are of 75 mm. caliber, the body of the caisson being tilted when the gun is in action, and also forming a shield, as in the case of the French regulation gun. The Krupp guns throw a shell of 14⅓ lbs., the muzzle velocity being 1640 foot-seconds, and the range 6233 yards. Each gun carries 44 rounds of ammunition, and each caisson 96 rounds.

Russian and Japanese Field Guns, etc.

FIELD ARTILLERY.

Russia.—Till recently the Russian Field Artillery has been armed with (*a*) 3.42-inch guns firing 15½ lb. shells, with a M. V. of 1700 f. s., and weighing 38 cwt. in draught; several patterns of these guns were and are in the service. (*b*). 4.2-inch guns, firing 28 lb. shells with M. V. 1450 f. s., weight in draught 42½ cwt. (*c*). Six-inch mortars firing 60 lb. shells with 760 f. s., M. V., weight 41 cwt.

In 1897, Russia took up the question of rearmament of her field artillery, and experiments were continued till 1900, when a pattern (3-inch caliber) was approved and large numbers (it is said 1500-2000) were ordered. The Russians do not seem to have been altogether satisfied with this gun, as it appears further trials were undertaken; and a new pattern was approved in 1902, and orders for the supply of this gun have also been given. No details have been published of this latter (1902 pattern) gun, and it seems doubtful if it has been yet issued for service. Details of the 1900 model are given in the table below; it does not seem to be strictly speaking a Q. F. gun; the gun recoils on the carriage, recoil being checked by a hydraulic buffer and by india-rubber pads,* which also run the gun out again; the carriage jumps somewhat on firing, the sights recoil with the gun, there are no seats for the layer or other number to sit on, and there is no shield. Fixed ammunition, with shrapnel shell only (it is believed), is employed with this gun. The breech mechanism is of the interrupted screw type.

As the three-inch model 1900 guns are issued, the 4.2-inch guns are withdrawn; it is also understood that the 6-inch mortars are regarded as out of date, and they are possibly being replaced. (They were introduced after the war of 1877-8).

Japan.—Up to 1901, Japan had a bronze 9-pounder Krupp field gun, but in that year a new pattern steel gun was issued and rearmament is now complete. The new gun is known as the Arisaka gun, and not many details have yet been published about it; it has screw breech mechanism and recoil is checked by drag shoes with spikes or spades underneath. "Separate" ammunition is used. The Japanese mountain gun is similar to their field gun, but has an M. V. of 850 f. s., and a range of 3000 yards. The field artillery ammunition columns are formed of 2 wheeled one-horse carts and of pack animals.

	RUSSIA.		JAPAN.
	3.42-in. MODEL 1895.	3-NCH. MODEL 1900.	ARISAKA
Caliber, inches	3.42	3	2.95
Weight of shell, lb.	15½lb.	13½lb.	11 lb.
No. bullets in shrapnel	200	260	——
Muzzle velocity	1700 f.s.	1950 f. s.	1660 f. s.
Estimated rounds a min.	5	16	6 to 7
Range with time fuze, yds.	4500	6000	5000
No. of rounds in limber	30	36	40
Diameter of wheel, inches	55	52	55
Weight in draught, cwt.	38 cwt.	35 (?37) cwt.	——

The Russian Horse Artillery is armed with a 3.42-inch gun very similar to the field gun of that calibre; its M. V. is, however, only 1600 f. s., and its weight in draught is about 32¾ cwt. All Russian field batteries are 8-gun batteries; horse artillery batteries have 6 guns only.

Allotment of Artillery.—A Russian army corps comprises 2 infantry divisions with 112 guns and a cavalry division with 12 guns. Each infantry division includes 2 infantry brigades (each brigade being composed of 2 regiments=8 battalions), and one field artillery brigade which has 48 guns in one division and 64 guns in the other division of the army corps; the strength of a division may be taken as about 14,000 infantry and 48 (or 64) guns.

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* India-rubber pads have been in use in the Russian Artillery for some time, and have been favored by General Engelhardt who has been responsible for much of the Russian equipment. These pads are used in the 3.42-in, Model 1895 gun-carriage and in the 6-in. mortar, to lessen the blow on the axle-tree.

The Japanese regular army is not organized in army corps, but in 13 divisions. A division includes 2 infantry brigades (each of 2 regiments of 3 battalions), one cavalry regiment (about 400 sabres), and one artillery regiment (field or mountain) consisting of six 6-gun batteries. The strength of a division is about 10,000 infantry and 36 guns.

Small arms.—The following are the chief particulars of the rifles used by the two nations:

	RUSSIA "3-LINE." 1891 PATTERN.	JAPAN "30th YEAR" 1900 PATTERN.
Caliber	.3-inches.	.256 inches.
Muzzle velocity	2,000 f. s.	2,300 f. s.
Weight of bullet	213 grains.	163 grains.
" with bayonet	9 lb., 12 oz.*	9 lb., 8½ oz.
" without bayonet	——	8 lb., 9½ oz.
Rounds in magazine	5	5
Loading system	Charger	Charger.

The Japanese "30th year" rifle superseded the Murata rifle which had a caliber of .314-inch. and fired a 225 grain bullet with a M. V. of 2000 f.s. It had a tubular magazine in the fore-end holding 8 cartridges.—*Proceedings Royal Artillery Institution*, April, 1904.

Changes in Field Artillery Equipment and Their Effect on the Action of Artillery in the Attack.

QUICK-FIRING FIELD ARTILLERY.

Manufacturers have for a long time concentrated their attention on increasing the rapidity of fire of the field gun. The imaginations of some enthusiasts have even pictured an automatic machine emitting a stream of shells controlled only by an electric button, without considering the all important conditions imposed by the necessity for laying, the correct setting of time fuzes, and supply of ammunition. Within certain limits, however, rapidity of fire constitutes a reserve of power which has become a necessity. The manufacturers recognized that rapid fire was useless unless aimed, and that to attain rapididity of laying the carriage must be as motionless as possible. Two main ideas were followed in attempting to obtain a motionless carriage, the one was to anchor the carriage, with the gun rigidly fixed to it, as firmly as possible to the ground, the other to allow the gun to recoil on its carriage and return to the firing position by the action of springs, and thus to make it easier to prevent the carriage itself from recoiling. The Germans and Italians were afraid of the complications of buffers and springs necessitated by the latter course, and adhered to the rigid carriage principle; but French ingenuity overcame the difficulties, and in 1897 they began re-arming their artillery with guns mounted on the recoil principle. The Russians followed suit, and most other nations, after watching developments carefully for some time, have decided in favor of the long recoil system. There is every reason to believe that the Germans and Italians are regretting their decision.

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* Bayonet always to be carried fixed; scabbards being left behind on service.

We are more concerned at present with the employment of the gun than with its details of structure; but it is worth noting that the countries from which the most adverse criticism of the French methods of using the gun has come, viz., Germany and Italy, are the two powers which decided not to adopt the long recoil system.

It had been found that the new carriage remained so steady that not only was the possible rate of fire greater than had been anticipated, but, also, it was possible for the men working the gun to keep their seats on the trail instead of having to stand clear of the carriage at each round. This fact at once made it worth while to put shields on the gun for the protection of the men. It is a remarkable fact that it was not till four years after the adoption of the gun that the instructions for its use appeared. This almost suggests the thought that the discovery of the high rate of fire attainable, and the possibility of armoring the gun, led to the invention of a system of employment based rather on the special qualities of the gun than on any modification of the accepted principles of tactics which had become necessary for other reasons. However this may be, the new regulations introduced some radical changes, and they have been spoken of as revolutionising artillery tactics. A keen controversy about the ideas propounded by the New French School has been in progress since the adoption of the new gun, and though the appearance of the Regulations in 1901 silenced French military writers, in other quarters the dispute was renewed with vigor, and included now a discussion of the meaning and value of some of the paragraphs in the new book.

The changes that have been introduced are based on the supposition that a storm of shrapnel bursting over a given area of ground will paralyze every movement within that area. As the suddenness of the squall is an important factor, time must not be wasted in exact ranging, though every precaution is taken to conceal the battery and to make every possible preparation before the first shot is fired. An examination of the technical question of ranging does not come within the scope of this paper. Volumes have been written about it, thousands of rounds have been expended in experiments, and tens of thousands of practice records have been searched in the attempt to solve difficulties which we may safely leave to the Artillery Schools to deal with; but we may take it for granted that close accuracy in ascertaining the correct elevation and direction, as well as the length of fuze, is not conducive to rapidity. But the French theory is dependent on rapidity; they count on hitting the enemy before he can hit back, on knocking him down when he is not looking and keeping him down; and to do this they sacrifice exact ranging to rapidity, and trust to the storm area including the enemy somewhere and to its being violent enough to reduce him to inaction. These squalls, or *rafales*, are necessarily short, some 60 to 80 rounds are expended in five or six minutes, the number varying according to the difficulties of ranging. It is true that in some cases, as shown in Examples 8 and 20 of the Règlement, a more careful ranging is then proceeded with, and the target (a battery in each of these cases) is destroyed at leisure.

The French system of artillery tactics is based on this method of fire and on the assumption that it meets with invariable success. The first point in their tactics which attracts notice is that the principle which enjoins the simultaneous employment of the maximum number of guns from the very first is thrown overboard. This principle came into prominence after the Franco-Prussian War, and it assumes the existence of long lines of the enemy's guns, the overpowering of which forms the first stage of the preparation of the infantry attack. Our regulations lay down that the entire strength of the artillery shall be brought into action at the beginning of the engagement, and they prescribe concentration of fire on the enemy's batteries in detail after the process of ranging is completed. The holding of guns in reserve is in this theory held to be more than a waste of power, as it exposes a few batteries to the risk of defeat in detail.

The French regulations, however, forbid the opening of fire from more batteries than are required to cover the front which is being attacked. One battery of four guns is supposed to be able to cover 200 yards of the enemy's position with such an overwhelming fire that no other assistance is usually required. The number of batteries to open fire is thus limited by the extent of the enemy's position, and the remainder are held in readiness, some unlimbered and in firing positions, others limbered up ready to come into action in any direction; but in either case they clearly fulfil the function of a local reserve.

Great emphasis is laid on the necessity for concealment before opening fire. The regulations not only insist that the approaches to the position must be hidden, but they point out that the batteries in action or in the waiting position must be hidden, must be defiladed from view from every point in the enemy's position. They assume that once fire is opened the locality of the batteries will be disclosed by the flash and dust of the guns if for no other reason, and that they would be overwhelmed by the rapid fire of the enemy's guns were it not for the precautions taken. They assume that the results of these precautions are (1) that the enemy have no idea as to the position of the batteries until they open fire, (2) that every yard of the enemy's position is being watched by a battery allotted for the purpose, and (3) should an enemy's battery have the temerity to disclose itself and open fire, that it will be silenced before it can find the range. The whole system is based on these assumptions, and if they are found to be extravagant or unwarranted it fails.

In the preparation of the attack the whole of the batteries which are to direct their fire on the selected point or points are placed under one command, but they are divided into two portions, the first of which, divisional artillery as a rule, is ordered to accompany the infantry, by successive rushes to within close range of the enemy's infantry, and thus give material and moral support to the decisive attack.

This manner of supporting the infantry by actual presence of the guns in the front line is attributed by some foreign writers to the introduction of shields, but when we remember that with every change of position the difficult process of ranging has to be carried out afresh, that during these necessarily exposed advances heavy losses among the horses may be expected, and that artillery are more easily stopped by horse losses than any other mounted troops, it is difficult to endorse the opinion that the fact of the gunners being to a certain extent protected while serving the guns is a sufficient reason for adopting a course of action which, whatever else it may do, will certainly not augment the fire superiority which is stated in our regulations to be essential for a successful assault.

FOREIGN OPINION ON QUICK-FIRING GUNS.

Among Italian writers General Biancardi and Colonel Allason have given the most prominent opinions. The former is in favor of French methods, which, in 1901, he described as pushing close in regardless of cover, except such as the shields afford, and overwhelming the enemy with rapid fire with H.E. shells. This drew a reply from Colonel Allason, whose chief objection lay in the difficulty of ammunition supply and consequent tendency to hold batteries in reserve till the critical moment. Biancardi answered that 312 rounds per gun was quite sufficient, and that, moreover, the fact the layers were undisturbed and the gunners but little fatigued conduced to fire effect and, therefore, to economy of ammunition. He thought it became entirely a question of tactics. With shields either policy is possible; without them only one course is open. He considered one French battery of four guns equal to three Italian of six guns each.

A French writer, "H.B.," in the Revue d'Artillerie, March, 1902, writes in explanation and defence of the new regulations, especially paragraph 620, which is not quite clear on the question of concentration of fire. He says the concentration referred to is that of widely dispersed batteries, and not "the convergence on one target of the fire of several batteries under one command," which is condemned, because if the enemy have shields three batteries can do no more than one towards temporarily silencing the adversary, whereas cross or enfilade fire will destroy him. He says this concentration will be automatic and not by intent, because batteries will instinctively fire at those they can enfilade in preference to those directly opposed to them. He claims that the new gun is worth ten of the old ones.

General Rohne, of the German Artillery, besides writing a book on the subject, has published a series of articles in the "Jahrbücher für die deutsche Armee und Marine," in the first of which in July, 1902, though favoring the French methods he criticises the last writer. He points out that against shielded artillery the rafale will only have a temporary effect unless H.E. shell is used, and in this case the expenditure of ammunition required to obtain the necessary hits would be enormous. He derides the idea of cross or enfilade fire because of the difficulty in directing it. He considers the claim of ten to one in favor of the new gun is an exaggeration. On the other hand he supports French opinion by saying "The modern artilleryman must learn to adapt his fire to the tactical conditions, and the guarantee of success lies in the capability for rapid ranging and in the fire discipline of batteries *rather than in bringing an enormous number of guns into action at the same time.*" We shall most of us agree with the first part of this sentence, but the comparison which he institutes may not be so generally approved.

In the meantime, both General Rohne and Colonel Allason have developed their views more fully, and in August, 1902, the Revue d'Artillerie announced its intention of publishing the opinions of these two eminent writers. It described General Rohne as a former advocate for a gun with accelerated rate of fire, but an ardent convert to a real quick-firing gun with shields. General Rohne's book was published by Mittler of Berlin in March, 1902. He is certainly enthusiastic about the French system as the following extract shows:— "The practice procedure prescribed for the new field gun signifies a breach with the past as complete as can be imagined. While the old Practice Regulations required an extremely exact ranging with a view to obtaining the greatest possible effect with the smallest expenditure of ammunition, special value is now set, and rightly so, on obtaining sufficient effect in the shortest possible time. Rightly, I say, for in battle, time is more valuable than ammunition; ammunition fired can be replaced, lost time, never." The whole paper is worth a careful study, but Chapter V, "Artillery in Action," is especially interesting.

Colonel Allason's opinions are in direct opposition to General Rohne on on every single point. His paper is almost entertaining in its boisterous ridicule and cutting sarcasm. It is a vigorous and searching criticism and condemnation of the French gun and French tactics from first to last. It would be unfair to Colonel Allason to attempt to summarize in a few lines the forcible and closely reasoned arguments he adduces. The paper itself must be read if justice is to be done to it; but the concluding paragraph may perhaps be quoted to show the tendency of the writer's views and the warmth of his feelings on the subject:—"The main question is not shields, or no shields, or even the manner of firing quick-firing guns. No, the real question is whether the ideas emanating from Langlois and his partisans have led or will lead to the discovery that artillery fire carried out with direct laying, observation of results, and consequently ranged and rationally conducted, has truly become obsolete and useless for war, and whether it has been discovered that there is another manner of using artillery (which may or may not be continued to be called by this name), i.e., an unconscious fire, not layed, not observed, not ranged, carried on with a mad rapidity by something which is called a machine directed by an intelligence, but in which I clearly see the machine, but can no longer distinguish the intelligence. Such is the question, and the nation which makes a mistake in its solution will find itself in a grave inferiority on the day of battle. I only wish that Italy may not be that nation".

A French writer in the "France Militaire" of November 7th, 1902, asserts that hostile critics are actuated by a desire to keep up their own courage in view of the possibility of having to encounter such a superior weapon as the French gun before they have had time to re-arm with a similar gun. The whole paper is, however, so lacking in the quiet confidence of concious superiority, so intolerant of the unbelievers, and so loud in praise of the French gun, that one is very much inclined to suspect the very motive which he attributes to others.

Of a very differerent character, however, is the work of Major Rouquerol, which has recently been translated into English by Captain Radcliffe. He argues every point with great fairness, though, as might be supposed, his last word is in every case in favor of the French gun, and their method of employing it. The book will, however, for a long time be considered the most complete exposition of the teaching of the new school, as well as of the employment of field artillery in general.

The September, 1903, number of the Revue Militiare Suisse has a good paper on the employment of artillery in the attack, by an Italian officer, Major Pistoj. The writer makes many good points, and on the whole seems to favor the new theories.

LONG RANGE.

The increased range of modern guns is a factor which has not received so much attention as their rapidity of fire. With the old guns we spoke of 2,500 to 3,500 yards as "distant" ranges, whereas now the figures are 4,500 to 6,000, and accurate fire is possible to even greater distances. In considering how to make use of this extra power we must remember that of the ground thus brought within range a much larger proportion is hidden from the guns than is the case at shorter ranges, unless, indeed, the whole country is a perfectly flat plain. We must, therefore, either abandon the hope of bringing this hidden ground under fire or we must learn to shoot at targets which are not visible from the vicinity of the guns. So far as can be ascertained we alone are paying attention to this. We are developing a system which will enable the fire of guns to be controlled from a point far to a flank or in advance of the guns. It has been successfuly applied to the case of a single battery on service, and in a more extended form to a brigade at peace practice. The dispersion of the batteries does not materially increase the difficulties of the system, and we can thus secure the larger choice of positions and the effect of convergent fire which results from dispersion. Provided we are careful to avoid the complications which peace conditions allow to creep in, but which active service peremptorily rejects as impossible, there is every reason to hope that such a system may be of considerable value during the earlier stages of a prearranged engagement. This system would be of especial value to the heavy artillery. They could come into action on any ground which afforded good platforms without searching, often in vain, for an ideal position which would give them a view of some twenty square miles of country, which lies within their range.

FIELD HOWITZERS.

The employment of howitzers in the field is not very modern, but it is only recently that the question of the best method of dislodging, by artillery fire, troops securely posted behind cover has received serious attention. Experiments were first carried out with ordinary field guns firing reduced charges so as to obtain a steeper angle of descent, but the results were unsatisfactory, partly because the use of shrapnel necessitated a considerable remaining velocity, and therefore the angle of descent could not be steep enough, but mainly because a gun shoots better with one charge than with any other, and that charge is usually the full charge for which it was designed. The next attempt was to fire common shell with H.E. from guns with their proper or full charge, and to burst the shell by means of a time fuze at the exact moment that it passed over the parapet to be attacked. This method failed owing to the difficulty of getting a fuze which would burn with sufficient regularity and which could be set accurately enough to ensure its bursting at precisely the right fraction of a second. The rifled howitzer throwing a heavy shell, with high angle of elevation and consequent steep angle of descent, then made its appearance. The principle of the howitzer was soon admitted to be satisfactory, but opinions, especially in Germany, differed widely as to its weight, the description of projectile to be used, and its tactical employment. Some people contended that a light field howitzer was unnecessary, as a heavier one could do all that was required of the lighter piece, and more besides, while others maintained that the heavier howitzer would never be in the right place at the right time. The arguments for and against a light mobile howitzer as opposed to the heavier weapon, and also as to the relative merits of shrapnel, common, and the so-called torpedo shell were closely discussed in foreign military periodicals, though not perhaps with such warmth as the quick-firing question. The general opinion now seems to be that both types of howitzers must be provided, because the conditions to suit the varied requirements cannot be combined in one design. On the one hand, high angle fire with shrapnel or H.E. common shell is considered essential to support the infantry attack of any intrenched position, and it may have to be applied at any point where resistance may unexpectedly be encountered or as the progress of the battle may necessitate. To fulfil this duty a considerable number of light howitzers is wanted which are capable of rapid movement to any part of the field, including possibly a turning movement by mounted troops. On the other hand, if the enemy has had time to prepare defenses on a large scale, a heavier shell is necessary to penetrate overhead cover which in these circumstances might easily be solid enough to keep out the lighter shell of the field howitzer. In this case, however, more time would be available in which to bring up the required artillery, because the conditions more nearly approximate to siege conditions, and time is the important factor which marks the difference between siege and field work. A heavy howitzer which may be even a day's march in rear of the lighter batteries will quite meet the case. The two types would weigh about 28 and 50 cwt., respectively, behind the teams, with calibers of 4¼ and 6 inches. Those nations which cannot afford both natures, are trying for a compromise in the shape of a 4¾-inch howitzer, weighing about 42 cwt. behind the team, but it is not likely to prove satisfactory in either set of conditions.

During the South African war one great advantage of high angle fire was brought to notice which is of great importance to the infantry, but which so far as can be ascertained has not been referred to by any of the foreign writers. Shrapnel fire from flat-trajectoried guns can keep the enemy down in his trenches, but he is fairly safe there, and when the infantry arrive within a certain distance of those trenches—the French regulations mention 500 metres—the guns must raise their sights and lengthen their fuzes. This will be the time for the defenders to jump up, fresh and comparatively unskaken, to pour a heavy fire on the attackers, who after an exhausting and trying advance still have some 500 yards of bullet-swept glacis to cross. If, however, howitzers are supporting the attack, not only are the defenders more demoralized by being exposed to their fire, even in the deepest trenches, but the attacking infantry can approach much closer—up to 100 or even 50 yards—before the howitzers need cease their fire.

SUMMARY.

The changes in armament which we have been considering seem to suggest the following points on which, though there are many others, we may for the present concentrate our thoughts:—

(*a*) To what extent should we hold artillery power in reserve?

On any one day on which a decisive engagement is to be fought our available resources in guns, horses, and ammunition are, practically speaking, limited to a definite quantity, and we have to utilize them in the manner best suited to the attainment of the end in view. We must study economy and yet be prepared to spend with a free hand when occasion demands. The French system of fire tactics is based on rapidity of fire, and without rapidity, both in ranging and in effective firing, it falls to the ground. If ammunition were as plentiful as sand on the sea shore, rapid fire would rule the day, and their system might justify the claim of revolutionizing artillery fire tactics. But as matters stand it will perhaps be wiser to consider rapid fire as a reserve of power to be used exceptionally and not as a general rule. The same principle of economizing power so that there may be no lack of it at the critical moment is applicable, though in a lesser degree, to horses, and consequently to guns, as their presence at a given time and place depends on the horses. The increased destructive effect of quick-firing shrapnel will make the unnecessary exposure of horses during the earlier stages of a fight a more serious matter than ever. It is probable that the idea of keeping guns themselves in reserve will not meet with approval, but it may be as well to remember that as counter-attack is an essential part of successful defense, we should so dispose our guns as to be prepared to meet it.

(*b*) How can the artillery best help the infantry during their advance?

The increased range of modern guns will probably lead to their being first brought into action in positions from which they cannot so effectively support the infantry after they have begun their advance, as formerly when the artillery first positions were at a closer range. Much will depend on the features of the ground; but it seems probable that for the second stage, a general advance of the guns will be necessary to a position from which they can establish the requisite superiority of fire, and can command as much ground as possible; such a position, in fact, as is described as ideal in our regulations. The French manner of bringing the artillery forward by successive rushes during this stage has already been referred to; but would it not be better to advance the guns as rapidly, and as far as may be necessary to secure their final position, but to let them stay there and develop their fire power to the fullest extent? The best moral support which the infantry can have will be the conviction that the artillery are doing their utmost to afford them the material support of fire effect. Their confidence in the artillery may, however, be put to a severe test, because even at this stage economy of ammunition will have to be thought of in view of the requirements of the final stage, and the firing may of necessity be comparatively slow, or even intermittent. It is, however, of great importance that all ranks in the artillery should be acquainted with the plan of attack, so that they may know where their own infantry are likely to be at any time, and that the artillery commanders may appreciate the relative importance of the movements in progress, and regulate their fire accordingly.

(*c*) Action of artillery during the final stage.

As, however, the crisis approaches, every battery will quicken its rate of fire, and guns and howitzers, with the exception perhaps of those batteries told off to advance on to the captured position, will be ready to use their last reserve of shells.

This leads to the question of how long the artillery are to keep on firing at the trenches. In South Africa the clear atmosphere allowed battery commanders in most cases to see the front line of their own infantry, and to judge the best time to stop firing at the defenders' front line, but under different conditions of weather and light, this might not be such an easy matter, and it has been suggested that some system of communication should be arranged, so that the infantry might decide the exact moment for themselves. At first sight this idea seems attractive, but the arrangements would have to be very complete and well rehearsed between the infantry and artillery, and there would always be the risk of misunderstanding on account of the divided responsibility. The close support which field howitzers can afford makes it especially desirable that we should come to some understanding with the infantry on this point. We want to know in the first place when the guns are to raise their sights and alter their fuzes; secondly, when the howitzers are to do the same; and thirdly, what is the best plan for ensuring that the change in each case is affected at the right time. The infantry must make up their minds on these points. Some officers have said that to retain the advantage of the covering artillery fire for as long as possible, they would sooner take the chance of some loss due to a badly set fuze of their own artillery, than to incur the much heavier losses caused by the increased fire from the defenders, when the latter find that they are no longer under artillery fire. The earlier the artillery cease firing the longer will be the exposure of the infantry to this increase of fire.

CONCLUSION.

Tactical questions are much more fully and accurately discussed in the public press abroad than is the case with us. On the other hand Continental nations have not the advantage of modern war experience, and it is possible that their writers and theorists are building up a structure which the first storm of bullets and live shell may sweep away for ever. Whether this will be the fate of the French Artillery system time alone will show; but at any rate we ought not to accept their conclusions without a most careful examination in the light of our recent experience of war conditions. We may find that they will not survive this test, and that the word "revolutionize" is not only too strong, but is not even applicable. In short, we may find that the alterations consequent on the introduction of quick-firing long range guns will be in the form of amplification of our present system, rather than of change in its character.—*Extracts from Lecture by Lt.-Col. A. H. Gordon, R. A., before the Aldershot Military Society.*

Prize Firing in 1903 and Some Comments.

Appended is a summary of the results obtained at prize firing in three principal British fleets with the 12-inch and 6-inch guns. Figures for 1902 are also given where possible to enable a comparison to be made, and the shooting of the best ship on each station is noted in the column of remarks. The difference in rates of fire and hitting of the 6-inch Mark VII. and 6-inch Q.F. is so slight that they have been summed together for the purposes of this return. The average rates of fire and hitting, etc., in the latest marks of 9.2-inch guns, obtained from the prize firing results in 1903 of four cruisers of the Cressy class, have also been given. The excellent shooting of the 12-inch guns in the Channel and China squadrons is worthy of note, and generally a 10 per cent. improvement on the 1902 figures is shown. There is a general improvement to be noted in the rates of fire and hitting with the 6-inch gun throughout the fleets, although the actual percentage of hits is no higher.

We do not anticipate, under the present conditions of prize firing—which are given below—any great advance in the future on the 1903 results with 12-inch and 6-inch guns. The rate of fire with the 9.2-inch may very possibly go up to three rounds per gun per minute, but an average of 2.5 is good, seeing that this type of gun and mounting have not long been in the service.

The percentage of hits to rounds fired averages about 50 throughout. At battle range from 3000 to 6000 yards it, as far as may be judged from the results of recent long-range firing, would be about 20; under battle conditions probably not more than 10 to 15. Against actual ships the Japanese made 15 per cent. hits at 3000 yards at the battle of the Yalu. The rate of fire would probably also fall about 50 per cent. Five rounds a minute with

Prize Firing Results in Three Principal Fleets, 1902-1903.—12-inch Mark IX.
Target 15 feet high, area 525 square feet, range 1400—2000 yards, speed eight knots.

Fleet and year.	Number of guns.	Number of rounds.	Number of hits.	Per cent. hits to rounds.	Rounds per gun per minute	Hits per gun per minute.	Nnmber of minutes per gun.	Remarks.
China, 1902	16	76	36	47	0.79	0.37	6	Best ship H.M.S. Ocean— Rounds per gun per minute 1.04 Hits 0.71
" 1903	20	118	73	62	0.98	0.61	6	Best ship H.M.S. Ocean— Rounds per gun per minute 1.17 Hits 0.75
Mediterranean, 1902	40	239	94	39	0.99	0.39	6	
" 1903	44	241	107	44	0.91	0.40	6	Best ship H.M.S. Bulwark— Rate of firing 1.25 Rate of hitting 0.63
Channel, 1902	?	?	?	?	?	?	6	No data.
" 1903	20	157	83	53	1.30	0.69	6	Best ship H.M.S. Majestic— Rate of firing 1.54 Rate of hitting 1.00
Total (two fleets), 1902	56	315	130	41	0.94	0.39	6	
" (three fleets), 1903	84	516	263	51	1.02	0.52	6	

Prize Firing Results, 1902-1903.—6-inch Mark VII. and 6-inch Q.F.
Target 15 feet high, area 300 square feet, range 1400—1600 yards, speed 12 knots.

China, 1902	110	1062	575	54	4.83	2.61	2	Best ship H.M.S. Ocean— Rate of fire 6.79 Rate of hitting 4.89
" 1903 (Q.F.)	130	1542	807	52	5.93	3.10	2	Best ship H.M.S. Goliath— Rate of fire 6.67 Rate of hitting 4.04
Mediterranean, 1902 (72 6in. Mk. VII.; 131 6in. Q.F.)	203	2003	1104	55	4.93	2.72	2	
Mediterranean, 1903 (108 6in. Mk. VII.; 95 6in Q.F.	203	2068	1189	57	5.09	2.93	2	Q.F.: Best ship H.M.S. Gladiator— Rate of fire 5.63 Rate of hitting 3.75 Mk. VII.: Best ship H.M.S. Bulwark— Rate of fire 7.33 Rate of hitting 4.08
Channel, 1902	?	?	?	?	?	?	2	No data.
" 1903 (Q.F.)	83	875	423	48	5.26	2.55	2	Best ship H.M.S. Majestic— Rate of fire 6.42 Rate of hitting 3.67
Total (two fleets), 1902	313	3065	1679	55	4.89	2.68	2	
" (three fleets), 1903	416	4485	2419	55	5.39	2.91	2	

Prize Firing Results, 1903.—9.2-inch Mark IX. and X.
Conditions as for 12-inch.

Four ships of Cressy class	5	119	64	54	2.48	1.33	6	Best ship. H.M.S. Hogue.— Rate of fire 2.58 Rate of hitting 1.66

the 6-inch and three rounds with the 9.2-inch could not be kept up for more than a short period.

Objection is frequently raised to the shortness of range at prize firing, and unless prize firing were supplemented by long-range firing, the objection would be very largely justified. It must be remembered, however, that prize firing is essentially a test of the gun layer, and it is desirable to eliminate as far as possible all errors due to bad range-finding, a faulty system of fire control, etc. These are tested at the long-range firing under battle conditions—which might very well be carried out more frequently—whereas all that is tested at prize firing is the men behind the guns. Therefore the practice is carried out at short range by single guns—i.e., one gun fires at a time, not all together—and the shortness of range is neutralized as far as possible by the small area of the target, which is of only two dimensions instead of three—as would be the case in reality—and which presents a vertical area of only $\frac{1}{20}$ that of a modern first-class cruiser.

The great value of the heavy guns is apparent from the tables. In mere weight of metal striking per gun per minute, the 12-inch gun is superior to the 6-inch as 4 is to 3, and the vastly superior penetrative powers of the heavy shell, coupled with its very much larger bursting charge, make their relative values nearer 40 to 3.

The 9.2-inch is probably of as great, if not of greater value than the 12-inch, at any rate up to 3000 yards, beyond which, of course, the heavier shell has the advantage. Capped 9.2-inch shell of good quality striking directly can get through 7 inches of K.C. up to 4000 yards, and in cases where, as in the United States, armor-piercing shell—*vide* Report Chief of Bureau of Ordnance, 1902—strength is not sacrificed to a per cent. or so of bursting charge capacity, such a shell may even take its bursting charge through its own caliber of hard-faced Krupp steel. In weight of metal striking per gun per minute it is to the 6-inch very nearly as 2 to 1. In fact, the 6-inch is out of date both as an armor piercer and as a shell gun, and nothing under a 7.5-inch should be placed on any future battleship, disregarding, of course, the light, quick-firing armament of 12-pounders and the like.

Weight of shell as under:—

in.	lb.
12	850
9.2	380
6	100

The bursting charge of an armor-piercing shell is from 4 to 5 per cent. of its weight. —*The Engineer*, February 26, 1904.

Wireless in War.

The strenuous manifesto of the Russians against the use of wireless telegraphy by neutrals within the zone of hostilities is timely and to the point. It has, to be sure, a pungent flavor that will hardly commend it to representatives of the daily press, but it is well that we should understand that modern war is neither a golf match nor a yacht race, and that whosoever intrudes upon it does so at his peril. We presume that there will be protests about the liberty of the press, the rights of neutrals, and Muscovite barbarism; but the fact remains that although the introduction of wireless telegraphy has introduced a new and important feature into war correspondence, Russia is apparently well within the rights insured to belligerents by the ordinary precedents, or absence of them, which make up the body of international law. That the protest has come from Russia rather than Japan is simply an indication that the former, under the sting of defeat and disaster, feels more acutely the necessity for it. We should much dislike to be on board a press boat which had been warned off from dogging the fidgety fleet of the genial and versatile Admiral Togo. There has been no proclamation, but a twelve-inch projectile is quite sufficiently exterminatory, and it is not always easy to distinguish signals in a bad light. In point of fact, the Japanese regulations for war correspondents are quite as drastic as the Russian, and neither are unusually or objectionably severe from the standpoint of international law. They are stricter than those in vogue here during the Spanish fracas, but one of the weakest points in our military and naval system is the undue weight given to impertinent and incompetent "public" opinion.

Let us look a little into the status of wireless telegraphy, and see what are the precedents by which it must be determined. It is, of course, a new method of transmitting intelligence, but in its results it is the same so far as the interests of the belligerents are concerned. Its long range gives it unusual powers, good or ill, which must be taken into consideration. Now to begin with, a wireless telegraph outfit on its merits as merchandise, would unquestionably be held to be contraband of war if consigned to a belligerent and would be subject to seizure like any other contraband article even upon the high seas. It is no less contraband if found actually in use to the advantage of a belligerent, even if in the possession of a neutral and upon the high seas. As to the full personal responsibility of the users, no question can properly be raised under the rules and usages of war. To quote from our own Articles of War: "Whosoever shall be convicted of holding correspondence with, or giving intelligence to, the enemy, either directly or indirectly, shall suffer death, or such other punishment as shall be ordered by the sentence of a court martial." And in time of war a court martial is fully recognized as having complete jurisdiction over violators of this article whether they owe allegiance to the United States or not. No man who circulates about in the zone of hostilities collecting and disseminating information with a hand ever so impartial, can be excused on the ground that he is neutral, or that he is gathering news for the general benefit. If his acts are such as are in themselves calculated to convey even indirectly, information concerning one belligerent to the other, he must, if caught, take his chances of noose or bullet, for he is trespassing on the playgrounds of Death, and doing it knowingly. Nor can he escape because his operations within the zone of hostilities chance to be upon the high seas, which are not neutral territory, but merely the common highway of nations on which belligerents are accorded paramount rights. It will be interesting to watch the action of the American Government in the premises.

A wireless press message sent from the seat of war to neutral territory endangers the rights of belligerents peculiarly for two reasons. First, it is at best intended for general publication, which implies conveying news of the acts or intentions of one belligerent to the other. Second, it may by accident or pre-arrangement be directly intercepted. In either case the sender is clearly in the position of giving information forbidden by the usages of war. Even when the zone of hostilities is upon the high seas, neutral vessels enter it, unbidden, at their peril, and cannot act as spies or conveyers of information except at their own risk. Even war vessels of neutral nations upon the scene for purposes of private observation with the acquiescence of the belligerents, must be extremely circumspect in their acts. We do not think we overstate the case in saying that for a war vessel of a neutral power to send wireless dispatches for publication to a neutral port giving information to all the world of the movements of belligerents, would properly be considered an unfriendly act by the injured belligerent and would constitute a justifiable *casus belli* if repeated. We have all sympathy with the hard and dangerous task of a war correspondent; it is in every way desirable that neutral powers should learn of the progress of hostilities, but it is well within the rights of belligerents to determine in how far it is safe to allow their movements in the zone of hostilities to be made public, to regulate the transmission of news from within their own lines and throughout the region in which they are operating, and to suppress, if need be by extermination, the injurious acts of spies, eavesdroppers and busybodies, within the entire zone of hostilities. Trespassers in that zone must remember that their rights there are secondary to those of the belligerents, and that no professions of neutrality will excuse them in hostile acts, in which category the unauthorized sending of wireless messages must certainly be placed. There is no international law forbidding it, but it is done at the sender's imminent peril. And even if some dictum or precedent in international law could be adduced apparently favorable to the opposite view, it would not avail against the principle of self-preservation, which in affairs of nations can always be appealed to as paramount. In fact, lacking a tribunal for its interpretation with command of bodily means for its enforcement, the so-called law of nations may be likened to the "gentlemen's agreement," of which the keeping depends on self-interest—especially the self-interest of the stronger party. Meantime, Russia will go slow and as a matter of electrical technique we are heartily glad to see such splendid work done with wireless telegraphy, in messages hundreds of words long—and with American apparatus at that, in American hands.

—*Electrical World and Engineer*, April 23, 1904.

Submarine Boats.

One can almost sympathize with those ardent enthusiasts—the naval strategists (who, of course, deplore bloodshed, and all that; but, still, if there must be fighting, would like to learn something from it)—in their disappointment at the course the war in the Far East is taking. Here we have two Powers, each owning a fleet comprising some of the most death-dealing engines of modern warfare, and though hostilities commenced over six weeks ago, we have learnt nothing. It is true we have had one or two striking object-lessons which may be useful in bringing home more closely previously recognized axioms of warfare; but there has been nothing really new. Thus the attack on the fleet at Port Arthur, with its disastrous results to the Russian ships, has shown that torpedo craft may be effective against unprepared battleships or cruisers, but that was proved so long ago as the Russo-Turkish War; if not before, during the American campaign of the Northern and Southern States. We have also learnt—or, rather, been shown—that a fleet, without soldiers to help, cannot force a well-protected land position; that it is folly to pit ships against forts is a recognized fact, in spite of the teaching of Alexandria. The way in which Japan is making use of the command of the sea is a lesson older than Napoleon, in the gunpowder days, and as old as Hamilcar if we go beyond them. At present there appears no prospect of that illuminating full-dress engagement between ordered fleets which was to set so many vexed problems at rest, and thus establish a standard for strategy and tactics. Indeed, it is not impossible that the Russo-Japanese conflict may be almost as barren of results for the naval strategist as the Spanish-American war; and, perhaps, from much the same cause.

These considerations apply to naval strategists in general—except, perhaps, those of the belligerent Powers; but to one small but extremely sanguine class the present war did not from the first give much promise. We refer to the submarine boat enthusiasts; and their disappointment must be more keen because there are now such splendid opportunities for this most modern engine of naval warfare to exhibit those particularly virulent qualities which its supporters claim for it. If Admiral Togo had even one or two of these craft to send into Port Arthur to destroy the Russian ships, or if the Russians could dispatch a few to blow up the Japanese fleet when next it appears for purposes of bombardment, the question would be settled, and the vaticinations of strategists fulfilled. Unfortunately for the attainment of this end, neither the Russians nor the Japanese appear to have turned their attention largely to the submarine boat. It is true that the former are reported to have constructed secretly some of these vessels for service in the Black Sea, and that others are to be sent from the Baltic; but either of these bases is a long way from Japanese waters, and the voyage by sea seems hardly more promising than a journey by the Trans-Siberian Railway. Whether the Russian Government ever became possessed of any of the 300 Goubet boats which were said a year or two ago to have been ordered, is extremely doubtful; at any rate, if the Russians have had any successful results with craft of this nature, they have kept the fact secret in a way that is not usual, and would scarcely be politic; for it has been as much Russian policy to appear strong as to be strong.

The submarine boat strategist is, therefore, once more reduced to peaceful experiment, and here the records are not very encouraging.

In the February issue of the Journal of the American Society of Naval Engineers Lieutenant W. R. White, U.S.N., gives details of his experience during the trials of the Adder and the Moccasin, which are two of the six submarine boats of the Holland type authorized by Congress in June, 1900, although seven vessels have apparently been built. These boats have cigar-shaped hulls, every cross-section being a circle, the greatest diameter being 11 feet, 10 inches. The length is 63 feet, 4 inches. Each boat has a single three-bladed screw, 6 feet in diameter and 3 feet, 11 inches mean pitch; its efficiency is low, a fact attributed to its small size, to its small pitch ratio, and to the speed at which it is driven. The motive power is supplied by a four-cylinder gasoline engine of 160 horse-power for use when the boat is running not entirely shut in, so that the air supply can be renewed. For submarine purposes there is a 60-horse-power four-pole shunt-wound electric motor which runs at 800 revolutions per minute, and receives current at 115 volts from storage batteries having a capacity of about 1900 ampere-hours at the normal rate of discharge. There are 60 cells. No provision is made for preventing the overflow of acid when the boat pitches or rolls; a defect to which attention is called.

The oil engine does not reverse, and therefore the electric motor is used for maneuvering. The boat is submerged by the use of diving-rudders, or by filling the trimming and ballast-tanks. When the proper quantity of water had been admitted, the boat is very sensitive to the action of the diving-rudder, but a speed of at least six knots is needed to control the vertical movement. To come to the emerged position, water is expelled by the use of compressed air carried in storage flasks. The diving and vertical rudders are worked by hand; for experience has shown that more satisfactory results are secured by relying on the intelligence of the crew than by depending on the presumed certainty of action of automatic devices, which are liable to fail at critical times. In vessels that are so much submerged, even when at lightest trim, the provision for ventilation is an important feature. For this purpose, first there is a ⅓-horse-power Diehl motor and a Roots blower near the engine. Another smaller motor is placed near the stern of the boat, and for ventilating the battery tanks there is a ¼-horse-power motor. Air is supplied through the conning tower and the torpedo hatches, and also through a 4-inch ventilator. Air is exhausted from the top of the forward end of the engine room by a ⅓-horse-power motor and blower by means of a 2½-inch pipe, which is said to be too small.

The other five boats, in addition to the Adder and Moccasin, are the Grampus, Pike, Plunger, Porpoise and Shark.

Before the advent of these vessels, the United States Navy possessed one submarine boat—the Holland, which was commissioned about four years ago. In speaking of this vessel, Lieutenant White says: "Although the craft has had a very daring, capable, and energetic commmander, there is no official record that she has ever done submerged work off the entrance of the principal harbors except for the briefest interval. This type of boat is designed to operate in such localities, not in land-locked and shallow harbors."

This remark reaches the heart of the case, for it is in submerged work in other than enclosed water that the submarine finds difficulties arise. In shallow land-locked waters it acts as well as any other deeply-laden small-freeboard oil-motor launch.

The Adder and the Moccasin, as will be seen, are similar in type to the first boats built by Messrs. Vickers, Sons, and Maxim for the Royal Navy, the dimensions being almost identical, although, no doubt, smaller than the design provided for in subsequent estimates. The particulars of these vessels have not, however, been made public. The American boats are, of course, smaller then some foreign vessels, such as the Gustave Zédé and Morse. The fact that these American boats are similar to those in our navy gives the details of their trials additional interest. We do not propose to repeat the details of all trials, but will select those which seem of especial interest.

The boats were tried under three conditions—namely, light, awash, and submerged. The light condition is that of ordinary cruising trim, the motive power being obtained solely from the oil engine. In the trials awash, also, the gasoline engine only is used, but the vessels are trimmed as for diving, excepting that the main ballast-tank is empty, and the conning-tower hatch-cover is kept open. The boat is then suppposed to be able to dive at short notice, it being only necessary to stop the gasoline engine, fill the main ballast-tank, start the electric motor, and secure the necessary six-knot speed. In the submerged runs the boats have a reserve of buoyancy of about 300 pounds, this being corrected by the horizontal rudders, so as to keep the boats beneath the surface.

In the light condition the Adder made 8.732 knots; awash the speed was 8.12 knots; and submerged, 7.08 knots. The Moccasin did rather better submerged (7.244 knots), but not quite so well under other conditions. The Adder also ran for 10 nautical miles at 8.86 knots. In this vessel also the gasoline engines were run for 12 hours, being stopped once on account of the igniter of a cylinder blowing.

It may be said generally that the machinery of these vessels behaved well, and the trials tend to show that petrol-engines, when well designed and properly attended to, are fairly trustworthy motors.

During the three-hour submerged run of the Adder, the conning was done by means of a periscope temporarily rigged through a ventilator. The instrument was fixed, and had a field of view of but 15 degrees on each bow.

Nevertheless, the boat remained submerged without coming to the surface to take an observation, her average depth, as shown by the gauge, being about 7½ feet below the surface. Lieutenant White insists upon the need of a properly designed periscope, so that the boat may remain below the surface for a couple of hours, and not have to come up constantly for observations. When there is the slightest disturbance of the water, he adds, vision through the lenses of the conning-tower is very difficult on account of the spray and water thrown on them. It is pointed out, however, that when using the periscope, it is absolutely impossible to judge distances with any degree of accuracy. The relative position of objects is quite apparent, but cases have been known where submarines have rammed a sea-wall, which, seen through the periscope, appeared quite distant.

An incident in the trials of the Adder, which was of some importance, occurred on the three-hour submarine run. The boat touched the bottom in about 29 feet of water, and hung for some time. Ordinarily, when submerged under way, the diving rudder is held at an angle of 9 degrees, and on touching the bottom it was shifted to 18 degrees in the opposite direction, but without effect. Two men were then sent aft, but the boat did not rise, and the main ballast tank was accordingly blown out. The force of the expulsion of the water and the additional buoyancy freed the boat, and she rose to the surface.

The bottom was of sand, and it was believed that only the fore part was touched ; but in commenting on this event, Lieutenant White says that the result might have been quite serious had the bottom been of a clay formation, as the boat would possibly have been imbedded to such an extent that the suction would have made it very difficult to free her, and expelling water might have been of little avail. The suggestion is made that a boat should be placed under shears, and a series of experiments made to find whether serious danger would arise through sinking a few inches into clay.

The time required to make ready for diving when the boat was in light condition was on one occasion 26 minutes. This time was occupied by stopping the gasoline engine, unshipping ventilators, clearing and securing the conning-tower hatch, filling the tanks, and connecting the electric motor to the propeller-shaft. On another occasion 29 minutes were consumed, but the Moccasin carried out the evolution in 25 minutes. It is said that if gauges had been fitted to show the correct trim fore and aft, the time needed would have been less.

As in the case of torpedo craft—although, perhaps, even to a still greater degree—the human factor plays a most important part in the success of submarine boat trials. The crew employed were picked men, thoroughly trained to the work, and the trials appear all to have been carried out under the direction of Captain Cable, of the Holland Company, whose experience no doubt greatly contributed to the success of these boats. One of the reporting officers states that no one has been able to get the same duty out of the men, and, therefore, presumably, out of the boats, as he has done. Whether this statement includes the *personnel* of the Navy, we are not aware, but possibly it does not.

The trials occupied only portions of seven days, each averaging about six working hours, yet the crew were very much worn out at the end of the tests, although they did not sleep on board, and even their meals were obtained on shore. It is well known that a mental strain of trials of this nature is a thing that few men can stand for long, and the fact suggests the importance of a more extensive *personnel* than would otherwise be needed for torpedo boats and submarine craft. Under the old conditions of warfare the unscientific rough-and-tumble operations called for no more mental effort or anxiety on the part of the rank and file than a game of football, and even comparatively little on those in higher positions. If there were no fighting, and men were not killed or wounded, they would last for an indefinite period. Now we see that even under peace conditions a full-power trial may lead to a state of prostration, the recovery from which needs some little time. Of course, in war the men would have to go on whether prostrated or not; but the result would then be inefficiency, surely followed by defeat, if opposed to fresh crews, unless there was some overwhelming advantage. The engineer has entirely altered the condition of naval warfare since our last great fights, not only in regard to material, but also in the needs for *personnel*. Nervous energy has taken the place of physical force; and nervous energy, when overtaxed, is something like a run-down battery—not easily restored. The rollicking, fighting Jack Tar of the Marryat school would not be much good for modern methods; and as intelligence becomes more acute, nerves are more highly strung, and breakdown is more to be feared. Submarine-boat crews may be practically decimated without meeting an enemy, and it is therefore needful to have a large body of supernumeraries to fall back upon. Unfortunately, they must be men of such high attainments as to be rare; and this is, perhaps, one of the weakest points of the submarine boat.

—*Engineering*, March 18, 1904.

U. S. Battleship Virginia.

The most recently designed American battleship, embodying the mature experience of the naval experts, is typified in the Virginia, which was launched from the yard of the Newport News Ship & Engine Building Co., Newport News, Va., on April 5. Congress in March, 1899, appropriated money for three coastline battleships carrying the heaviest armor and most powerful armament for vessels of their class, and increased this number by two of like character in June, 1900. Of the five vessels appropriated for three were required to be sheathed and coppered, and two were without sheathing. Immediately after awarding the contracts, however, the navy department took this question under consideration and decided to omit all outside sheathing and coppering, so that each vessel of the class is now a counterpart of the other, except for minor modifications incident to construction.

The general dimensions and chief characteristics of these vessels are: Length on load water-line 435 feet; breadth (extreme) at load water-line 76 feet 2½ inches; trial displacement about 14,948 tons; mean draught in trial displacement, about 23 feet 9 inches; greatest draught, full load, about 26 feet.

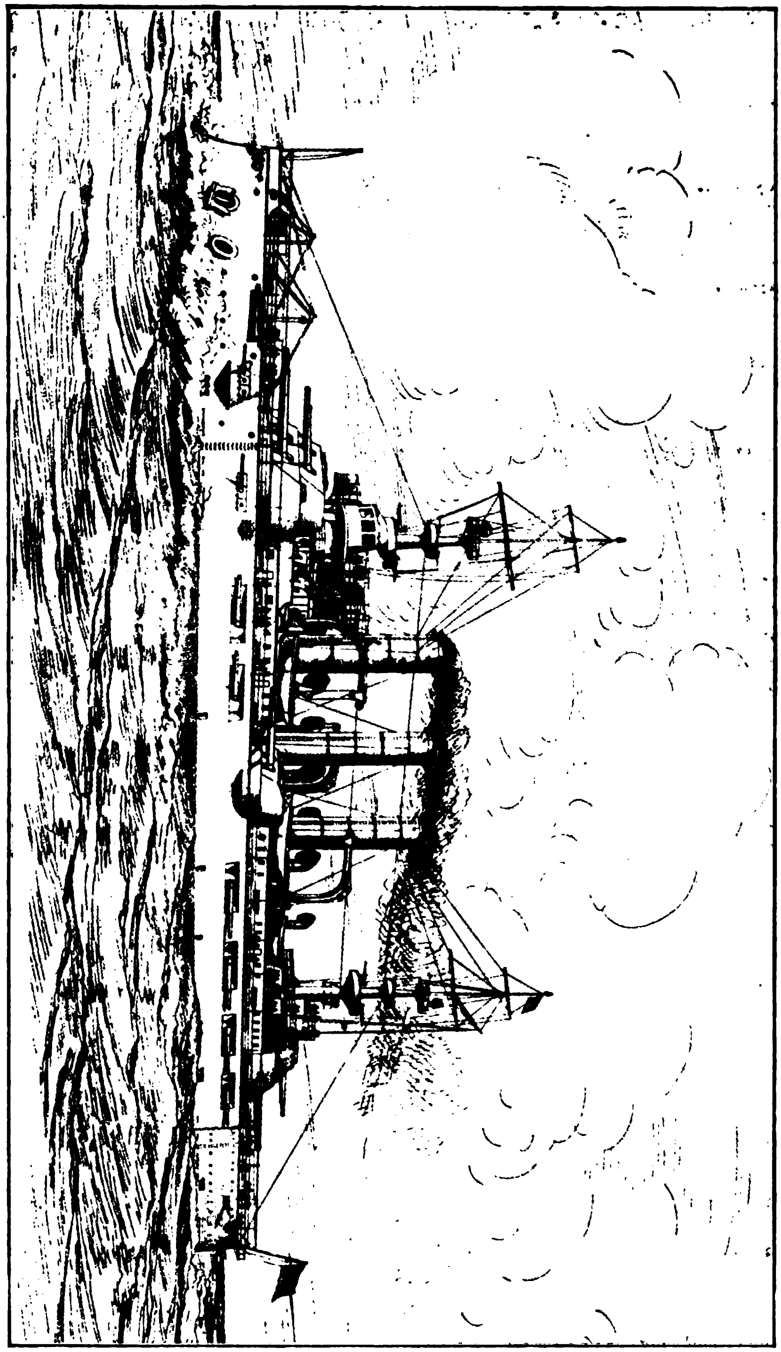
In the 15,000 tons represented in each of these vessels, the many antagonistic qualities essential to a perfect fighting machine have been compromised and incorporated in the proportion which experience seems to have pointed out as the most desirable and efficient. To begin with, these battleships will have a speed of at least 19 knots, which compares most favorably with any battleships under construction abroad, as well as with any in the projected stage.

The Virginia will carry four 12-inch guns, 40 calibers in length, mounted by pairs in balanced turrets, one turret being forward of the super-structure and the other aft, and each having a total arc of train of 270 degrees. Of the eight 8-inch guns, 45 calibers in length, which will be carried on this vessel, four will be mounted by pairs in turrets, superposed on the 12-inch turrets above mentioned, and four in two broadside turrets slightly forward of amidships, the amidship turrets having a total arc of train of 180 degrees. In the Virginia there will be a broadside battery on the gun deck of twelve 6-inch rapid-fire guns, 50 calibers in length, mounted six on each side, each with a total arc of train of 121 degrees. The secondary battery will consist of twelve 3-inch 50 caliber rapid-fire guns, twelve 3-pounder semi-automatic, eight 1 pounder heavy automatic, two .30 caliber machine guns and six .30 caliber Colt automatic guns, all mounted in commanding positions and having large arcs of fire. The Virginia will also be fitted with submerged torpedo tubes.

The magazines will be specially fitted to enable her to carry, with absolute safety in all climates, the new smokeless powder. Provision will be made in the magazines for the storage of at least sixty rounds for each of the 12-inch guns, 125 rounds for each of the 8-inch guns, 200 rounds for each of the 6-inch guns, 300 rounds for each of the 3-inch guns, and a plentiful supply of ammunition for the smaller guns.

So much for the vessel's offensive qualities. To make her defensive qualities proportionately great, she will be provided with a complete water-line belt of armor 8 feet in width admidships, 11 inches thick at the top and 8 inches at the bottom, tapering to a uniform thickness of 4 inches at the ends of the vessel. She will also have a casemate armored belt, extending over about 245 feet of her length, of a uniform thickness of 6 inches, rising from the top of the main belt to the upper or main deck, and joined at its after end to the barbette of the 12-inch turret by a 6-inch armored bulkhead, and having at its forward end an armored bulkhead of six inches thickness, extending from side to side, thus forming a citadel or redoubt, within which the 6-inch guns will be mounted. Within this citadel or redoubt, and extending from the forward turret to the after turret, light armor 1½ inches and 2½ inches in thickness will form subdivisions of the gun inclosures, thoroughly protecting the gun's crews from flying splinters and fragments of bursting shells. The barbettes for the turrets of the 12-inch guns are to be 10 inches in thickness for that portion outside of the redoubt or citadel, reduced to 7½ inches within. The turrets themselves will be protected by armor 12 inches in thickness. The 8-inch turrets will, in all cases, whether superposed or independent, be protected by 6 inches of armor, with 6½-inch port plates, and their barbettes will be protected by similar armor. The conning tower and its shield will be 8 inches in thickness, and the armored tube, 5 inches in thick, will be of sufficient size to receive all voice pipes, wiring, etc. In addition to the conning tower, there will be, aft, a second tower, known as the signal tower, which will be constructed of 5-inch armor. From the bottom of the water-line armor belt there will rise a curved turtle backed nickel steel protective deck, 1½ inches thick on the flat and 3 inches thick on the sloping sides, to make assurance doubly sure that no projectile of the enemy finds its way into the vitals of the ship. As an additional protection to stability, a coffordam belt, 3 feet in thickness, and packed to a density of eight pounds to the cubic foot, will be worked along the two sides, above the protective deck, for the entire length of the vessel.

The material of construction is the high quality of steel which has entered into all the vessels of our navy. The main, or upper deck, in addition to being built of steel, will be the only one upon which wood is to be laid. The



The U. S. Battleship Virginia as She Will Look When Completed.

lower decks will all be of steel, covered with linoleum. The use of wood in the construction of this vessel will be limited even more strictly than it has been in the later battleships, and all woodwork above the protective deck, except deck plank, will be fire-proofed. Bilge keels and heavy docking keels are fitted.

The applications of electricity on board are much wider than in the case of any other battleships in existence, with the possible exception of the Kearsage and the Kentucky. All the turrets have electrical turning gear, and the ammunition hoists, blowers to the turrets and general ventilation, the general workshop and practically all of the auxiliaries outside of the engineer's department and excepting capstan and steering gear, are to be electrically driven. To provide for the power required for these purposes there will be installed eight engines and dynamos, mounted on combination bed plates, two having a rated output of 1,250 amperes at 125 volts and six with 625 amperes at 125 volts.

Take it all in all, the designs of the Virginia class embody the latest developments in naval architecture, and these vessels will prove most formidable additions to the fighting strength of the navy.

Battleships for Japanese Navy.

The two powerful battleships to be built for the Japanese navy by Vickers, Sons & Maxim at Barrow-in-Furness, and by Sir W. G. Armstrong, Whitworth & Company at Elswick, in addition to four 12-inch guns mounted in pairs within barbettes of 9-inch hardened steel, will have in the four quarters of the upper deck a 10-inch gun within barbettes of 6-inch armor, covered with armored hoods. Within the battery on the main deck there will be on each broadside five 6-inch guns and centrally situated on each side of the upper deck one more of the same caliber, making in all 12 guns of 6-inch caliber. For repelling torpedo and submarine attack, there will be twelve 12-pounders, three 3-pounders and six Maxims, with the addition of six underwater torpedo-firing tubes. This is the most powerful gun battery of any battleship, as 10-inch guns take the place of 9.2-inch weapons in the King Edward class, while there are also two additional 6-inch quick-firers. The 10-inch guns fire 500-pound shot with an energy of 28,000 foot-tons as compared with 20,000 foot-tons of 380-pound shot with the 9.2-inch guns. The general lines of armor protection, incorporated for the first time in the Mikasa built by the Vickers company will be followed and extended. The waterline belt will be 9 inches thick, then to the level of the upper deck there will be 6-inch armor; and there will be introduced for the first time, 4-inch armor above the level of the upper deck. No part of the upper works will be unprotected except for a length of about 80 feet forward and 88 feet aft. The guns behind the broadside armor will be separated by armor bulkheads. The 12-inch guns are to be 26 feet above the loadwater line, the 10-inch guns 22 feet and the main deck 5-inch guns 14 feet. The sea speed is to be 18½ knots, attained with twin-screw, four-cylinder, triple-expansion engines, supplied with steam from twenty Niclausse boilers. The total coal capacity of each will be 2,000 tons, and no feature of importance in the fighting capabilities of the ship has been forfeited to give the primary elements of offense and defense. The length of 455 feet is 30 feet greater than in the case of recent British battleships; but beam and draught are about the same—78 feet 2 inches and 26 feet 7½ inches respectively. The displacement is 16,4000 tons, and about the same as the King Edward class.—*Marine Review*, April 28, 1904.

BOOK REVIEWS.

The Life of John Colborne, Field-Marshal Lord Seaton. By G. C. Moore Smith, M. A. New York: E. P. Dutton & Co., 1903.

Between Field Marshal Sir John Colborne, first Lord Seaton, and Robert E. Lee, there are many points of resemblance which would probably have been still more accentuated had not our civil war occurred and had Lee lived out his life peacefully as an officer of the United States army. Both men, while still young, exhibited bravery, prudence and vigilance while in the field far beyond their years. Both men were trusted unreservedly by their commanding generals in difficult situations—the one in the Peninsular, the other in the Mexican war. Both men had that innate sense of strategy which enables a soldier to read and interpret an enemy's designs from the slightest significant movement of his troops. In personal appearance, too, both were singularly tall and handsome. Lastly, both men had a similar austerity of manner, accompanied by great kindness of heart, by a mercifulness of disposition, which was never lost even in the fiercest excitement of battle, and by a devout belief in Christianity which sweetened and ennobled their whole lives.

John Colborne was born in the South of England in 1778. He was educated at Christ's Hospital, London—the "Blue-coat School"—and at Winchester School. He received a commission as ensign in the 20th Regiment in 1794, when he was only sixteen years of age. His first active service was with the expedition to Holland in 1799, which was commanded by the Duke of York. The first time he was under fire was while he was on picquet duty near Krabbendam, on the high road to Alkmaar where the French were in force. The picquet consisted of raw militia only ten days embodied, but Colborne spent the night in throwing up intrenchments and when the French attacked at dawn they were easily repulsed. As a result of the commendations which he received from Sir John Moore, Sir Ralph Abercromby and others for his services in this campaign, Colborne was made a brevet-captain in January, 1800, though not yet 21.

Colborne next served in the expedition to Egypt under Sir Ralph Abercromby in 1801, was quartered in Malta from 1802 to 1805, and distinguished himself at the battle of Maida in the Calabrian Campaign of 1806. Although the British beat the French handsomely in this battle, Napoleon's successes in Germany set free overwhelming forces to operate against the mere expeditionary British force in Southern Italy, so that the latter was forced to retreat across the straits of Messina into Sicily. Here Colborne became military secretary to General Fox, and, after his recall, to Sir John Moore. He was now senior captain of his regiment and expected his majority to which he was gazetted on January 21, 1808, while in England. He accompanied Moore, still as his military secretary, in the inconclusive Swedish expedition in 1808, and, on the return of this expedition to England, went on immediately to Portugal with the intention of rejoining his regiment. He arrived at

Lisbon with Sir Harry Burard and Sir John Moore, just in time to see the close of the battle of Vimiero where Junot had been repulsed with heavy loss by Sir Arthur Wellesley.

Sir Harry Burard, who was at that moment the senior officer, prevented Sir Arthur from following up his victory and totally destroying the French force. Next day Sir Hew Dalrymple, senior to Sir Harry Burard, arrived and concluded the absurd Convention of Cintra by which the French Army in Portugal was allowed to capitulate on condition of being sent back to France in English ships. The outcry in England over the terms of this Convention was so great that Sir Hew Dalrymple and Sir Harry Burard, two of the most fat-witted old muffs that ever incumbered an army by commanding it, were ordered home to England, as was also Sir Arthur Wellesley. We may say, in passing, that the *esprit de corps* of the British Army at this time was so great that these two old fogies escaped that dismissal from the service which they so richly merited.

Meanwhile, the recall of the three senior officers left Sir John Moore in command. In the campaign which followed and which ended with the battle of Corunna and the death of Sir John Moore in January, 1809, Major Colborne was military secretary to his old chief. That this work was highly appreciated is evident from the fact that almost the last words which Moore spoke before he expired was a message to the Duke of York, then Commander-in-Chief, requesting that Colborne should have the first vacancy as Lieutenant-Colonel, which he duly received a month later.

The Peninsular War was now to begin in earnest, Sir Arthur Wellesley being despatched to Lisbon with a British army in April, 1809. Sir Arthur wanted to make Colborne his military secretary, but the offer was declined, apparently much to the temporary displeasure of Wellesley. Owing to the death of his step-father and the consequent settling-up of family affairs, Col. Colborne did not reach the front until after the passage of the Douro and the battle of Talavera. He was at once sent to the Spanish army of La Mancha where he made himself useful in abstracting the information contained in the numerous despatches captured by the Spaniards, but of which they seemed to be able to make no use. After the Spanish defeat by Soult at Ocana, Colborne was appointed to the command of the Second Battalion of the 66th Regiment of British Infantry, which formed part of Sir Rowland Hill's corps.

The capture of Almeida, early in 1810, left Massena free to concentrate his force of 70,000 men. Wellesley at once retreated to Busaco, where he was joined by Hill's corps, the combined army consisting of 25,000 British and 25,000 Portuguese. Then followed the retreat to the lines of Torres Vedras before which Messena vainly sat until his army had to retreat in the early months of 1811, severely crippled by hunger and disease, and with its *morale* all but completely destroyed.

Owing to the absence of senior officers on staff duty, Colborne had been commanding the 1st Brigade of the British Division of Hill's Corps, almost from the day he had taken command of the 2nd Battalion of the 66th Regiment. He had shown his adequacy in outpost duty at Torres Vedras, and was part of the advanced guard which harrassed the rear of Massena's army during its retreat up the valley of the Mondego. It was while on this duty that Napier, the historian of the Peninsular War, speaks of Colborne as "a man of singular talent for war," and of his Brigade as having marched 250 miles in 11 days—a great feat if the condition of the Spanish roads in those days is taken into consideration. He was in command of this brigade at the bloody battle of Albuera, when it was almost cut to pieces owing to the refusal of the Spaniards to advance. Beresford, who was in command, had 32,000 men of whom only 7,000 were British troops, the remainder being Spanish and Portuguese. Soult attacked with 24,000 men, and although defeated and forced to retreat, inflicted a loss of 6,000 killed and wounded, five-sixths of whom were British, on Beresford's force. Colborne and his Brigade were highly complimented in despatches for their gallantry.

Shortly after Albuera, Colborne was appointed to the command of the 52nd Regiment, one of the most justly famous in the British Army. The 52nd at this time formed part of General Robert Crawfurd's Light Division and had been trained as light infantry by Sir John Moore. Before the storming of Ciudad Rodrigo, the capture of the outlying fort of San Francisco, which was necessary to that operation, was intrusted to Col. Colborne. Although this was a night attack, so complete were his arrangements and so clearly did he make his orders understood by each of his subordinates that there was no confusion and the fort was captured twenty minutes after the assault had begun. He received high praise for this exploit from Lord Wellington, who was always chary of his compliments, and even from Crawfurd who seldom praised anyone for anything. Ten days later (January 19, 1812) the great assault on Ciudad Rodrigo took place, during which Crawfurd received his death wound and Colborne was so badly wounded that it was not until eighteen months later that he was able to join his regiment.

Colborne was at the head of his regiment again in July, 1813, just in time to see the first assault on the Fortress of San Sebastian. After the battles of the Pyrenees, and the fall of St.Sebastian and Pampeluna, the Light Division, then under the command of Gen. Alten, was pushed forward to the bridge of Vera. There is no need to recount the story of the storming of the heights of Vera, and the capture of La Petite Rhune at the battle of Nivelle. In both of these actions, Col. Colborne was in temporary command of a brigade of the Light Division and greatly distinguished himself by his daring and coolness. He was back in command of the 52nd at the Battle of Orthes where one pithy sentence from Wellington's despatch tells the story: "This attack led by the 52nd Regiment dislodged the enemy from the heights and gave us the victory."

We have given at greater length than we intended an outline of Colborne's services in the Peninsular War, and thus must pass rapidly over the remainder of his life. At Waterloo, the 52nd, under his command, contributed materially to the rout of the Imperial Guard in Napoleon's last desperate effort to pierce the British line. He remained in active command of the 52nd Regiment until 1821 when he accepted the post of Lieutenant-Governor of the Island of Guernsey. He was next promoted to the lieutenant-governorship of Ontario in 1828, which he vacated in 1836 to assume the office of Commander of the Forces in Upper and Lower Canada. In 1839 he became Governor-General of Canada, returning to England the same year, when he was raised to the peerage as Baron Seaton with a grant of £2,000 a year for three lives. He went out to the Ionian Islands, then a British possession, in 1843 and remained there six years. In 1853 he took command of the instruction camp at Chobham. He was too old in 1854, being then 76, to go out to the Crimea, but became Commander-in-Chief in Ireland in 1855, a post which he retained until 1860. On his retirement he was made a field marshal.

Lord Colborne died in 1863, in the 85th year of his age. He had been happily married in 1811, and Lady Seaton survived him for nine years. The story of his life as written by Mr. Smith has not a dull page in it, though it hardly equals in vivid portrayal the same author's account of Sir Harry Smith. This, however, we believe is more due to Lord Seaton's unconquerable modesty and reserve than to any other cause. We congratulate Mr. Smith in having rescued from partial oblivion the fame of a soldier whose career is a model for emulation.

The Development of Tactics Since 1866. By T. Miller Maguire, LL. D. 8 + 133p. O. London: Hugh Rees, Ltd., 124 Pall Mall, S.W. 1904. Red cloth, 3 shillings, 6 pence.

In the British army a provision of the new regulations requires candidates wishing to enter the army to pass an examination in the history and development of the tactics of the three arms from 1866 to the present day. As there seems to be no suitable single book covering such a course, Messrs. Hugh Rees have brought out the work before us, which has been compiled by Dr. Maguire, the well-known English writer and authority on strategy and tactics.

The book is an interesting one in every respect. It is in no sense a textbook, though containing a large amount of data on which the military student may commence his studies in this subject, but is a well-rendered account of the development of tactics and its effects, illustrated by historical examples, with the able deductions of one who has carefully studied all campaigns since 1870 and who has had since that time the good fortune to have been brought into relations with some of the ablest narrators and critics of military incidents.

The author's style is clear and forcible and his book is entertaining as well as instructive. "Officers cannot be improvised, and an efficient professional education for soldiers is far more valuable to individuals and to nations than is the education of lawyers or of any other class of the community." "War is terrible, but it may be sublime. The fall of a State, or the unnecessary slaughter of thousands of its soldiers through ignorance, or indolence, cant or false economy, party spirit or luxury, is even more terrible, and for a nation of our wealth, numbers and resources to be unprepared to meet its enemies in the gate, is far worse than terrible; *it is utterly despicable.*"

Chapter I. on the general details of armament sketches broadly the evolution of infantry and artillery weapons during the period considered and the resultant effect of their fire. Chapter II. deals with the tactical effects of new weapons, more especially due to the introduction of smokeless powder and the magazine rifle. An historical summary of tactical changes shows the battle-field action of infantry, cavalry and artillery in the wars of 1866, 1870-1, and 1877-8. It treats also of fire tactics, siege tactics, entrenchments, etc., and indicates the effect of these campaigns on the art of war as shown by their lessons being embodied in subsequent Field Exercise Books in Europe, examples of which are taken from the various British drill books, including Combined Training, 1902.

Chapter IV. is an extremely interesting one on the tactics of to-day. The war in South Africa is the theme here, and the author's views together with some prominent foreign opinions are given. Then follow some examples of modern battles, mainly historical: Königgratz, 1866; Sedan, 1870; Lovtcha, 1870; Kaiping, 1894; Santiago, 1898; and Elandslaagte, 1899. "It must in all these studies be remembered that none of the great Continental strategists or tacticians believe that the lessons, so called, of various recent campaigns can apply to some great future war such as might take place on the frontiers of France or Prussia. On the other hand, all authorities pay most careful attention to any tactical lessons that can be learned either as to regular or guerilla warfare, from our South African experiences."

Several good maps of some of these battlefields accompany the text.

There is much pertaining to the use of artillery in the book, but the author does not discuss the question of modern rapid-fire artillery except incidentally in considering the advantages of superiority of fire effect.

The book should prove very useful for the purpose intended and can be read with interest and profit. What information we have of the events in the Far East gives point to a number of the deductions made, and where differences occur it is well to remember that it is impossible to fight battles in accordance with a sealed pattern. How to achieve success cannot be prescribed for all situations. The genius of the commander, his military insight must find it out. But there are lessons in everything that has been done in war—and even left undone, for that matter—and this admirable book presents many such lessons of value to officers of all grades.

English-Spanish Manual. By First Lieutenant R. G. Hill, 20th U. S. Infanfantry. Third Edition, Revised and greatly enlarged, by Major C. G. Morton, 6th U. S. Infantry. 128 p. Kansas City, Mo.: Hudson-Kimberly Publishing Co., 1904.

The importance of Spanish to our army has increased considerably in the past six years, and our colonies in the East, the construction of the Panama Canal, and the growing intimacy of our relations with the republics of Mexico, Central, and South America will probably serve to keep up and even increase our interest in that language.

Major Morton has extended the usefulness of this little manual and greatly improved it for the general reader, at the same time preserving its features as a military hand-book.

The blank pages inserted in the text still further increase its value to him who has constant use for it, and desires to preserve for future use what practical knowledge of the language he acquires as he goes along.

The volume is neatly and tastefully bound, and will no doubt prove useful in the field as well as in the office.

Militär-Lexikon. Handwörterbuch der Militärwissenschaften. H. Frobenius. Ergänzungsheft II. 80 p. il. & maps, Q. Berlin: Martin Oldenburg. 1904.

We have already endeavored to give an idea of this important work* and of the excellence of the main volume as a military dictionary. The present supplement contains the latest data on military subjects and completes the matter contained in the first supplement.

One of the principal articles is that on field guns by General Wille. This is very complete and gives details of all the modern long recoil equipments now being introduced, together with the status of the field-gun question in the various countries. Under heavy field guns is given the latest information in regard to these in Germany, France, and Austro-Hungary. The articles on machine guns, rifles, automatic pistols, breech mechanisms of guns are particularly good and well illustrated.

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* See JOURNAL, May-June, 1903, vol. 19, page 338.

Under the various countries—Germany, France, Italy, Japan, Russia, etc., is given their latest military and naval organization, together with the recent changes in all. The harbors of Bizerta, Gibraltar, Plymouth, Spezia are illustrated and their fortifications given.

But what we have already said in regard to the main volume applies equally well to this supplement. It appears to possess the same excellence as a useful dictionary for the military student of to-day, and completes the main work most satisfactorily.

The New International Encyclopaedia. Editors: D. C. Gilman, LL. D., President of Johns Hopkins University and of Carnegie Institution, Professor H. T. Peck, Ph. D., L.H.D., of Columbia University, Professor F. M. Colby, M.A., of New York University. Volumes XV, XVI, XVII. New York: Dodd, Mead and Company, 1904.

These volumes complete the great work of reference, the publication of which has been in progress during the past year. Our previous notices of earlier volumes apply with equal force to these later ones, which are fully up to the standard established at the beginning.

A résumé of the leading characteristics of this work, however, will not be out of place, and we proceed briefly to enumerate these:

1. The selection of the words and the material.
2. The mode of treatment of each subject.
3. Cross references.
4. Bibliography.
5. Pronunciation.
5. Illustrations.
7. Articles admitting of it are well up to date.

In the selection of the material and in prescribing the mode of treatment of each subject, of course, the judgment of the editors comes into play as the principal determining factor, and for this work their wide experience as educators particularly fitted them. Indeed, this element it is which makes the entire work so eminently satisfactory as a work of reference. The editors have had the good sense not to attempt to fill their volumes with classical abstruse treatises on the great subjects included, but to limit the articles to the kind of subject-matter the average reader would look for in such a work.

The cross-references in all the principal articles, as well as in some of the minor ones, are particularly convenient, while the bibliography at the end of every important article adds an element of interest as well as of completeness to the whole.

The article on Pronunciation gives a complete discussion of the principles of that subject, but for convenience the principles which find application in this work are summarized on the first page of each volume, so that the correct pronunciation of any word may be readily determined.

In the illustrations this work is particularly rich, and the selections are most happy. They include, besides the innumerable woodcuts scattered throughout the text, many beautiful and artistic colored plates, maps (many of them double page plates) and engravings (the last mentioned often excellent reproductions of the great works of art of the world). Each volume has six or eight colored plates, from eight to twenty maps, and thirty or forty full page engravings.

This great work, besides fulfilling its purpose as an encyclopaedia, is also most useful to the student of science, art, history and geography, as well as many other branches. Even special students will find the material satisfactory. Thus, the purely military articles in these three volumes alone include, besides the usual military geographical, historical and biographical articles, some seventy-seven articles, of which the following are the most important:

War, Strategy, Tactics, Staff, Staff Colleges and Schools, War College, West Point, War Game, Uniforms, Torpedo, Torpedo Boat, Torpedo Station, Siege and Siege Works, Small Arms, Military Roads and Railroads, Wellington, Waterloo, Vicksburg Campaign, Signal Corps, Target Practice, Sheridan, Sherman, Sampson, Schley, Schofield, Winfield Scott, South African War, Washington, Searchlight, Telemeter, Sights, Siege Gun, Sharpshooter, Salutes, Turret, Tent, Sergeant, Submarine Boat, etc.

Several of these articles are complete essays on the subjects treated, and, therefore, include many other definitions not necessarily indicated by the title of the article.

The entire work is now before the public to pass judgment upon. It appears to us to be the most generally useful and satisfactory of all the works of reference of this character now available.

Exchange and Book Notices.

The Naval Annual, 1904. Edited by T. A. Brassey, A. I. N. A. 8+486 p. O. Portsmouth: J. Griffin & Co., 2 The Hard. 1904. Blue cloth, 15 shillings.

The People's War in France, 1870-1871. By Colonel Lonsdale Hale. 12+284 p. O. London: Hugh Rees, Ltd., 124 Pall Mall, S. W., 1904. Red cloth.

Notes on Strategy and Military History. Compiled by Captain H. T. Russell, R. A. 12+206 p. D. London: Gale & Polden, Ltd., 2 Amen Corner, E. C. 1904. Red Cloth, 4 shillings.

Field Fortification. Notes on the text-books. By Major-General H. D. Hutchinson, C. S. I. Ed. 5. 12+245 p. D. London: Gale & Polden, Ltd., 2 Amen Corner, E. C. 1904. Red cloth, 4 shillings.

Report of the Chief of Ordnance, 1903. Volume 14 of the annual reports of the War Department for the fiscal year ended June 30, 1903. 186 p. O. Washington: 1903.

Le Système de Canons Démontables proposé par le Colonel P. S. Lycoudis de l'armée Hellénique et la Violation de Brevet commise par la Maison Vickers, Sons and Maxim, Limited. 19 p. 2 plates. Q. Athens. 1903.

Ballistic Tables. Table IV. High Angle Fire. Quadratic Law of Resistance. Computed by Lieutenant-Colonel James M. Ingalls, U. S. A., retired. Extended to include every degree of the value of the angle of departure, by the Artillery Board. 31 p. Q. Washington: A. G. O. 1903.

The Hudson-Kimberly Publishing Co. has brought out in convenient form **Napoleon's Maxims of War,** with notes by General Burnod, translated from the French by Lieutenant-General Sir G. C. D'Aguilar, C. B. The value of these well-known maxims of the great Captain is increased by the pertinent notes that illustrate the principles of the former by examples drawn from the history of the art of war. The collection is useful in showing how these maxims may be most successfully applied to this study.

Messrs. Gale & Polden send us the following numbers of their military series: **Notes on Army Signalling**. A handbook of reference for signallers.

Questions and Answers for the Imperial Yeomanry. By Captain C. H. Anderson-Pelham.

Aids for Manœuvre Duties. A little book in accordance with the English Combined Training and King's regulations, and containing a great deal of useful information for troops so engaged.

Notes on Mounted Infantrymen. By Captain L. Saunderson; a very practical manual dealing especially with the tactical work of the company in the field.

The Craftsman for June contains a number of attractive articles among which may be mentioned the following: Street Fixtures and Vital Art, by Milo B. Maltbie; The Relation of the Arts and Crafts to Progress; The Colorado Desert and California, with many illustrations; Oriental Rugs: Their Designs and Symbolism, illustrated; The Story of the Rug; The Play Principle; A Craftsman House; A Forest Bungalow; Manual Training. The illustrations are numerous and particularly pleasing.

Military Law Made Easy. With Appendices of the Examination Papers fully answered, with references to the Official Books. By Major S. T. Banning. Ed. 2, revised. 18+267 p. D. London: Gale & Polden, Ltd., 2, Amen Corner, E. C. Red Cloth. Four-and-six.

This excellent manual on British military law has been carefully revised and brought thoroughly up-to-date in accordance with army orders, making important alterations in the various examinations for promotion. Much new matter has been added, covering all the important points likely to be met with either in practice or in an examination. It will be found a systematic, clear presentation of the subject, showing the student what to learn, and assisting him greatly in acquiring this knowledge.

St. Memin Portraits. Dr. William J. Campbell the well-known bookseller of Philadelphia is writing an elaborate work on St. Memin portraits. It will be in eight volumes with over eight hundred and thirty engraved portraits all on separate pages. The basis of the book will be the famous collection of 761 proofs, made by the artist himself, which has recently come into Dr. Campbell's possession. The Corcoran Gallery of Art and the Library of Congress both of which have extensive collections are co-operating with the author, giving him the free use of any portraits that they possess that are not in his own collection. Any of our readers who have information either biographical or genealogical, about any portrait that St. Memin made, or any information as to the present location of any original crayons, coppers or engravings, will confer a favor on the author by communicating with him. Due credit will be given in the book for all information received. Dr. Campbell's address is 1218 Walnut Street, Philadelphia.

For the benefit of our readers who are interested in rifle shooting, and more particularly in long range and military rifle shooting, we once more wish to call attention to Dr. W. G. Hudson's book **Modern Rifle Shooting from the American Standpoint**. Probably no one in the United States writes with more authority than Dr. Hudson. Military rifle shooting is creating a furore all over the country, and in many States the National Guard State Rifle

Associations are throwing open their ranges to civilians. No more laudable departure can be made ; for it is by encouraging civilian rifle clubs that this broad land of ours will be made what it should be, a nation of expert riflemen. To become an expert rifle shot requires time and experience and many matters which the novice would take years to acquire are arranged in a most readable way in "Modern Rifle Shooting". Besides this the book contains formulas of value to all riflemen, the nitro cleaner formula alone being of great value to all users of nitro powders. The book is practically the only authority on long range shooting and the use of the Krag rifle, and the table of wind allowances given in it is something never before worked out. The book can be obtained by addressing Laflin & Rand Powder Co., P. O. Drawer 1002, Wilmington, Delaware. Price $1.00.

INDEX TO CURRENT MILITARY LITERATURE.

[For Abbreviations used in Index see first number of each *volume*.]

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High explosive projectiles.—**Scien. Amer.**, April 2.
Manufacture of smokeless powder at Granada.—**R. G. de Marina**, February.
Bronze ordnance.—**Amer. Mach.**, March 31; **Eng.**, March 11.
Question of naval ordnance, U. S.—**A. & N. Jour.**, March 26.
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Guns and armor for warships.—**R. Artig.**, December.
Swiss field material.—**Cercle**, February 20.
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The French mountain artillery.—**Mitth. Art. u. G.**, 3, 1904.
The new Italian field gun.—**Mitth. Art. u. G.**, 3, 1904.
Field-gun question in Austro-Hungary.—**Int. Rev.** Suplmt., March; **Wochenblatt**, 25.
Heavy field artillery.—**Art. Tids.**, 1, 2, 1904.
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Machine guns and machine-gun troops.—**Art Tids.**, 1, 2, 1904.
Experiments in Norway with the new field artillery.—**R. Artig.**, February.
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Norwegian long recoil field artillery material.—**R. M. Suisse**, February.
The R. F. gun in Holland and Germany.—**R. M. Suisse**, March.
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German military balloon service.—**R. Genie M.**, February.
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Cables for electric light and power.—**Elec. World**, April 2.
Preparation of materials for standard cells and their construction.—**Elec. Rev.**, April 16.
Electrical measuring instruments.—**Eng. C.**, April 15.
Electrolytic rectifiers for charging storage batteries with alternating current. —**Scien. Amer.** Suplmt., April 30.
Speed-torque characteristics of the single phase repulsion motor.—**Trans. Inst. Elec. E.**, February.
Mechanical construction of revolving field alternators.—**Trans. Inst. Elec. E.**, February.
Regulation of alternators.—**Trans. Inst. Elec. E.**, February; **Elec. Rev.**, April 30.
On turbo-dynamos.—**Elec. World**, March 19, 26.
Electric power in British shipyards.—**Cas. Mag.**, April.
Speed of electric motors.—**Eng'ing**, March 18.
The Dialt motor.—**Elec. World**, March 26.
The rated speed of electric motors as affecting the type to be employed.—**Elec. Rev.**, April 9.
Asynchronous generators.—**R. Artig.**, December.
The Edison accumulator.—**Genie C.**, March 26.
Edison storage-battery improvements.—**West. Elec.**, March 26.
Booster calculations.—**Elec. World**, April 9.
Action of light upon the formation of accumulators.—**Scien. Amer.**, April 16.

ENGINEERING, FORTIFICATIONS.

Military engineering in Spain and siege warfare.—**R. Artig.**, January.
Edison Portland cement works.—**Scien. Amer.** Suplmt., January 30.
Testing the soundness of cement.—**Scien. Amer.**, February 27.
On the prevention of dampness in walls.—**Mitth. Art. u. G.**, 3, 1904.
Wells and boring of wells in the Sahara.—**R. Genie M.**, March.
Desirable features in a transit for topographical surveys.—**Eng'ing News**, March 31.
Concrete piling.—**Scien. Amer.**, March 26.
Timber crib foundations.—**Jour. Eng. Soc.**, February.
Revetment of slopes of the Suez canal.—**Zeitschr. I. A. V.**, April 1.
Loam and clay in sand for concrete.—**Eng'ing News**, April 28.
Fallacy of the tests ordinarily applied to Portland cement.—**Eng'ing News.**, April 21.
The Ferguson cyclograph.—**R. Genie M.**, February.
Intrenchments for 3-inch Q.F. guns.—**Sbornik**, December.
On the installation of torpedo tubes in the harbor forts of Rio de Janeiro and the fortification of the ports of the coasts of Brazil.—**R. Mil. Brazil**, November, December, February.
Report of the work carried out in 1902-03, entrenched camp of Lisbon.—**Eng. Mil.**, October-December.
System of modern fortification.—**Int. Rev.** Suplmt., April.
Field fortifications according to Russian plans.—**Mitth. Art. u. G.**, 1, 3, 1904.

The walls of Lucca.—**R Artig.**, March.
Fortress warfare and pioneer troops.—**Kriegstech.**, 3, 1904.
Concealment of batteries. **R. Genie M.**, March.
German fortifications near Bale.—**R. Genie M.**, March.
Bulgarian fortifications.—**R. Genie M.**, March.

ENGINES, BOILERS, MECHANISM.

Cleaning steam boilers.—**Amer. Manfr.**, March 21.
Cleaning steam boiler surfaces.—**Amer. Elec.**, April.
Boiler scale. - **Amer. Elec.**, April.
Condensing steam for boiler feed.—**Eng. C.**, April 15.
Boiler horse-power.—**Eng. C.**, May 1.
Boiler design and boiler explosions.—**Eng. Mag.**, May.
Practical management of stationary steam boilers.—**Eng.**, April 15.
Gas and oil engines on shipboard.—**Eng'ing**, April 1.
Blaisdell tandem gas engine.—**Iron Age**, April 14.
Gas engine design, constants and formulas.--**Amer. Mach.**, April 14.
Combustion engines.—**Eng. C.**, April 15, May 1.
Experiences with gas and gasoline engines.—**Eng. C.**, April 15.
The Britannia oil engine.—**Page's Mag.**, May.
Internal combustion motors.—**Eng.**, April 22.
Motors of the future.—**Amer. Manfr.**, March 21.
Steam turbines.—**Zeitschr. I. A. V.**, March 25, April 1.
The Rateau steam turbine.—**Eng'ing**, April 8.
The steam turbine.—**Scien. Amer. Suplmt.**, April 30.
Steam turbines and their present importance.—**Umschau**, March 26.
Parson's turbo-motor.—**R. G. de Marina**, February.
Parson's steam turbine,—**Zeitschr. I. A. V.**, April 8.
Steam turbines.—**Jour. A. S. N. E.**, February.
The steam turbine and its field in marine work.—**Scien. Amer.**, April 9.
Recent developments in the Curtis turbine.—**Eng. C.**, April 15.
The steam turbine.—**Eng. C.**, April 15.
The De Laval steam turbine.—**Tech. Quart.**, March.
Causes of injector troubles.—**Eng. C.**, April 15.
Steam engine speed regulation.—**Amer. Elec.**, May.
Preparation for the erection of an engine.—**Amer. Elec.**, May.
Computing the horse power of an engine.—**Eng. C.**, May 1.
Metallic packings.—**Eng. C.**, May 1.
Morrison's limit rings for pistons.—**Eng'ing**, April 15.
On gear teeth.—**Zeitschr. I. A. V.**, January 29, February 5.
Engine valves and valve gears.—**Amer. Elec.**, April.
A new force feed lubricator.—**Iron Age**, April 14.
Crandall mechanical lubricating system.—**Iron Age**, April 14.

METALLURGY.

Modern steel manufacture.—**Page's Mag.**, March.
M. Guillet's investigations on manganese steel.—**Stahl u. Eisen**, March 1.
Electric resistance of irons and steels.—**Genie C.**, February 6.
Hadfield's steel works, Sheffield.—**Eng.**, April 22.
Molecular deformations of a bar of steel subjected to tension.—**R. Artillerie**, February.
Cementation of carbon steels and special steels.—**Memories I. C.**, February.

Report of the alloys research committee.—**Eng.**, March 18.
High-speed tool steel—its manufacture and use.—**Eng.**, March 11.
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Electric steel furnace at Gysinge, Sweden.—**Elec. Rev.**, April 2.
Alumino-thermics, or the production of high temperature by burning aluminum.—**Jour. Frank. Inst.**, April.
Electrical manufacture of steel.—**Elec. Rev.**, April 23, 30.
Some electric furnace processes.—**Cas. Mag.**, May.
Facts about high-speed tool steels.—**Page's Mag.**, May.
Relation of microstructure to the rate of cooling.—**Iron Age**, April 21.

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Control of the Pacific route.—**U. Serv. Mag.**, April.
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Russia on the Pamir and the fortifications of the Pamirskij post.—**U. Serv.**, May.

MILITARY HISTORY.

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The naval aspect of the war.—**A. & N. Gaz.**, February 20.
Russia's last hope on the sea.—**Scien. Amer.**, April 9.

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Artillery progress.—**A. & N. Gaz.**, January 9.
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War office reform: Report of Lord Esher's committee.—**U. S. Gaz.**, February 6, March 5; **A. & N. Gaz.**, March 5.
Army estimates, 1904.—**U. S. Gaz.**, March 5; **A. & N. Gaz.**, March 5.
Reorganization of the Canadian militia.—**A. & N. Gaz.**, January 2.
Military and naval notes on organization, changes, etc., in the forces of the principal Powers.—**Int. Rev.**, February, April, March.
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Report of the War commission.—**Jour. R. U. S. I.**, March.
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War as the ultimate form of economic competition.—**Proc. Naval Inst.**, December.

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Esprit de corps; how it may be strengthened and preserved under our present organization and system of promotion.—**Jour. M. S. I.**, May-June.

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Naval administration.—**Proc. Naval Inst.**, December.

On the employment of petty officers in the navy.—**R. Maritime**, March.

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England and the command of the sea in the Mediterranean.—**Rundschau.** February.

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